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The Institute of Vitreous Enamellers
The Welsh Engineers' and Founders' Association
The Foundry Trades' Equipment and Supplies Association

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Two Books

The issue of the Proceedings of the Institute of British Foundrymen in its new two-column format has merited and gained general praise. It is an outstanding volume from many aspects. Primarily it contains a full account of the International Congress held in London last June. This includes about 40 Papers emanating from all over the world, and now that it is possible to survey the Papers as a whole, it is somewhat surprising to find how different they are from a purely national conference. This is due to the inclusion of fourteen Papers of foreign origin, coupled with the fact that many of the British authors took cognisance of the international character of the audience. As a consequence, this section of the Proceedings is permeated with an endeavour to establish fundamental metallurgical principles or to enlighten the world as to national achievements. It is a matter for congratulation that these Papers were contributed by recognised experts, otherwise the value of the volume to future generations would be of questionable value. The best contribution under this heading is undoubtedly the Edward Williams Lecture given by Prof. W. L. Bragg, whilst Prof. A. Portevin's Paper on the compounding of alloys is worth re-reading at regular intervals. The contributions by British nationals were of uniform excellence, and especially does this apply to those of a practical character.

Turning to the Papers presented to the Branches, it can be asserted that without exception they are in every way equal to the standard of those presented to the International Congress. Moreover, certain others could usefully have been included but for limitations of space and weight. This volume was despatched simultaneously with a Report on Melting Furnaces for Grey Cast Iron, and together they absorbed four and half tons of paper!

The diverse nature and the amount of material contained in this volume are best exemplified by a study of the subject index, which contains over six hundred entries. This indexing has been particularly well done, and greatly enhances the general value of the book. There are about 520 pages in this volume of the Proceedings, which means that if the old format had been retained, a book of some 1,500 pages would have been necessary. In order to maintain the high standard now set, it will be necessary for a large number of Papers to be forthcoming, otherwise the next volume may look somewhat thin by comparison.

As a contribution to foundry literature, the book shows striking advancements have been made in pure research; fundamental principles; non-ferrous (especially light-alloy) foundry practice; core making; metal melting; high-duty cast iron; practical moulding; radiography; centrifugal casting; die-casting; cutting tools, and refractories. These are very live subjects, the development of which will take foundry activities to the very forefront of industrial enterprise.

The second book referred to in the title is the Report of the Melting Furnaces Sub-Committee of the Technical Committee of the Institute of British Foundrymen on "Melting Furnaces for Grey Cast Iron." This Report covers melting by the crucible, reverberatory, electric, rotary and cupola processes, supplemented by a chapter on melting costs. The matter is thoroughly up to date, and within its field it supersedes all existing textbooks. Its utility for either students or those envisaging the purchase of new plant cannot be questioned. The section on costing has not been included with the object of indicating the superiority of any particular type of furnace, but rather to indicate the factors which have to be applied in each individual case. Moreover, the Committee have selected different capacities of furnaces, their choice being governed by the size most generally employed in the industry.

The Report discloses that a vast amount of voluntary work has been carried through by the Committee. For instance, the labour entailed in establishing Table IV (a Summary of Replies to a Questionnaire on Cupola Linings and Patching Materials) was of no mean order, and Mr. L. W. Bolton, the Convener of the Sub-Committee, deserves special mention for the part he has played in handling the data. Finally, Mr. T. Makemson, who has edited both publications, is to be congratulated on having raised the standard of foundry literature to a particularly high level.

American Foundry Convention

PAPERS TO BE PRESENTED

The following Papers are expected to be submitted to the 44th Annual Convention of the American Foundrymen's Association, which opens at Chicago next Saturday (May 4).

"Cooling and Storage of Foundry Sand," by H. L. McKinnon, C. O. Bartlett & Snow Company, Cleveland.

"Foundry Equipment at Indianapolis Plant, International Harvester Company," by F. H. Amos, International Harvester Company, Chicago, Ill.

"An Adaptable Apprentice Programme," by A. L. Armantrout, Carnegie-Illinois Steel Corporation, South Works, Chicago, Ill.

"A Graduate Apprentice's Review of His Training," by C. W. Wade, Caterpillar Tractor Company, Peoria, Ill.

"Technique of Training Foundry Apprentices," by A. H. Wornom, Newport News Ship Building & Dry Dock Company, Newport News, Va.

"Composite Moulding in a Malleable Foundry," by Sam Healy, Saginaw Malleable Iron Div., General Motors Corporation, Saginaw, Mich.

"An Unusual Structure in Malleable Iron," by Enrique Touceda, Malleable Founders' Society, Albany, N.Y.

"A Sand Control Programme in a Malleable Foundry," by D. F. Sawtelle, Malleable Iron Fittings Company, Branford, Conn.

"Procedure to Obtain Maximum Physical Properties in Melting a Given Alloy," by Wm. B. George, R. Lavin & Sons, Chicago, Ill.

"Improvements in Gas Melting Furnaces in the Non-Ferrous Foundry," by E. W. Williams, Equitable Gas Company, Pittsburgh, Pa.

"Pattern Coating Materials," by Frank Cech, Cleveland Trade School, and V. J. Sedlon, Master Pattern Company, Cleveland, Ohio.

"Pattern Colour Markings," by G. V. Lustig, Barber-Colman Company, Rockford, Ill.

"Effects of Manganese in Second-Stage Graphitisation," by D. P. Forbes, P. A. Paulson and G. K. Minert, Gunite Foundries Corporation, Rockford, Ill.

"Heat-Treatment of Malleable Iron," by R. J. Cowan, Surface Combustion Corporation, Toledo, Ohio.

"Non-Ferrous Applications of Top Pouring Methods," by A. K. Higgins, Allis-Chalmers Manufacturing Company, Milwaukee, Wis.

"Comparison of Refractories for Cupola Service," by J. A. Bowers and Jas. T. MacKenzie, American Cast Iron Pipe Company, Birmingham, Ala.

"Linings for Desulphurising Ladles," by John Lowe, Vilter Manufacturing Company, Milwaukee, Wis.

"Flowability of Moulding Sands," by P. E. Kyle, Massachusetts Institute of Technology, Cambridge, Massachusetts.

"Effect of Sand on the Properties of Cast Iron," by H. W. Dietert and E. E. Woodliff, Harry W. Dietert Company, Detroit, Mich.

"Effect of Sand on the Properties of Cast Iron," by H. Womochel and C. C. Sigerfoos, Michigan State College, East Lansing, Mich.

"Notes on the Clay Bonding of Moulding Sand," by Harry L. Daasch, University of Vermont, Burlington, Vt.

"Cupola Control by Gas Control," by S. C. Massari, Association of Manufacturers of Chilled Car Wheels, Chicago, Ill.

"Application of External Chills," by W. F. McKee, Key Company, E. St. Louis, Ill.

"Recent Experiments with Grey-Iron Synthetic Moulding Sands," by Fulton Holtby and Herbert Scobie, University of Minnesota, Minneapolis, Minnesota.

"Some Considerations of Effects of High Temperature on Sands," by Dr. H. Ries, Cornell University, Ithaca, N.Y.

"Sand Control in British Foundries," by J. J. Sheehan, Austin Motor Company, Limited, Birmingham. (*Official Exchange Paper—Institute of British Foundrymen.*)

"Effects of Sulphur on Properties of Electric-Furnace Cast Irons," by Fulton Holtby and R. L. Dowdell, University of Minnesota, Minneapolis, Minn.

"Effects of Varying the Silicon Content of Cast Iron," by F. G. Sefing, International Nickel Company, New York City.

"Desulphurisation of Cast Iron from Practical Operating Standpoint," by W. Levi, Lynchburg Foundry Company, Radford, Va.

"Effects of Welding on the Structures of Some Cast and Wrought Steels," presented by the Lunkenheimer Company, Metallurgical Division, per A. J. Smith and J. W. Bolton, Cincinnati, Ohio.

"Chaplets in Steel Castings," by H. F. Taylor and E. A. Rominski, Naval Research Laboratory, Anacostia Station, Washington, D.C.

"A Safety Programme for Small Foundries," by P. E. Rentschler, Hamilton Foundry & Machine Company, Hamilton, Ohio.

"Workmen's Compensation and Occupational Disease Insurance," by Roger Bronson, Chicago, Ill.

"Ladle Additions of Graphite to Cast Iron," by A. H. Dierker, Ohio State University, Columbus, Ohio.

"Damping Capacity, Electric and Thermal Conductivities and Endurance Properties of Some Grey Irons," by C. H. Lorig and V. H. Schnee, Battelle Memorial Institute, Columbus, Ohio.

"Cast-Iron Cylinder Bores—Observations on Microstructure, Composition, Hardness and Wear," by E. K. Smith, Electro Metallurgical Company, Detroit, Mich.

"Tendency of Some Cast Irons to Seize Under Sliding Friction," by A. H. Dierker, Ohio State University, Columbus, Ohio.

"Report of Coke Specifications Proposal for A.S.T.M.," by B. P. Mulcahy, Citizens Gas & Coke Utility, Indianapolis, Ind.

"Application of Controlled Directional Solidification to Large Steel Castings," by J. A. Duma and S. W. Brinson, Norfolk Navy Yard, Norfolk, Va.

"The Pearlitic Interval in Grey Iron," by Alfred Boyles, Battelle Memorial Institute, Columbus, Ohio.

"Formation of Various Types of Graphite Patterns in Grey Cast Iron," by C. D'Amico, and R. Schneidewind, University of Michigan, Ann Arbor, Mich.

"Effects of Boron on Cast Iron," by G. M. Cover, Case School of Applied Science, Cleveland, Ohio.

In addition, there are numerous luncheon discussions, shop courses and the presentation of Committee Reports.

A.F.A. Gold Medal Awards

The awards made this year by the American Foundrymen's Association have a special interest for our readers, as amongst the recipients is Mr. Frederick A. Melmoth, who has received the Joseph S. Seaman Gold Medal. Mr. Melmoth is an ex-student of Sheffield University, where he received its premier metallurgical honour—the Mappin Medal. This was in 1913. After extensive steelmaking experience at Brown Bayley's Steel Works, he joined, in 1918, the staff of Lake & Elliot, Limited, of Braintree, the chairman of which is Mr. W. B. Lake, the President of the Institute of British Foundrymen. In 1926, Mr. Melmoth returned to Sheffield as foundry manager to Thomas Firth & Sons, Limited. In 1930, he went to America to join the staff of the Detroit Steel Castings Company, of which concern he is now vice-president, the American equivalent of managing director.

An award which will meet with general approbation in Great Britain is the receipt by Mr. H. W. Dietert of the Wm. H. MacFadden Gold Medal for his work on the control of foundry sands.

The John A. Penton Gold Medal has been awarded to Mr. N. K. B. Patch, who was President of the A.F.A. in 1930. Mr. Patch, who has done sterling work for the Association, is the secretary of the Lumen Bearing Company of Buffalo.

Finally, the J. H. Whiting Gold Medal is to be awarded to Mr. Frederick K. Vial, vice-president of the Griffin Wheel Company, where he has been responsible for the development of the hot-blast cupola process.

Random Shots

American foundrymen will be holding their annual conference next week in Chicago, where a large foundry and allied trades exhibition is also being held. "Marksman" is interested to note that the technical sessions all take place in the Saddle and Sirloin Club, but in this matter the London foundrymen are not advised to follow suit by staging a local meeting in the Ham Bone Club! According to the plan of the exhibition the Saddle and Sirloin Club is situated opposite the Girls' and Boys' Club, and a young English foundryman (a bachelor and a wag withal) wants to know if they are college girls. If so, he'd like to attend that conference!

* * *

It is also with no little interest that "Marksman" read of the famous lecture" given by Prof. E. H. Comstock, of the Minnesota School of Mines, on "Wildcats and Doodlebugs," which was given to a foundry audience in America recently. A wildcat may or may not be what it seems (and probably is not) but what on earth is a "doodlebug"? The professor warned his audience that the subject was not strictly appertaining to foundry matters, but, he said, "foundrymen look just as much like suckers as the other groups he had talked to"! That may be a pretty compliment over there, but in England any audience, foundrymen or not, would rise up in a chorus of protest and indignation; for here a sucker is just a sponger!

* * *

That good old foundry word "fettler" was the subject of discussion in a police court the other day, when a fettler was summoned for some minor offence. The learned judge put the question, "What is a fettler?" and the constable didn't know either, because he complained that when he himself had asked the same question of the defendant he had been told to mind his own business! In defence of such ignorance it must be added that the case was brought in a Southern county where most of the parlance of the foundry industries is so much Greek. One cannot imagine the same incident happening in Yorkshire, for instance, where the kitchen range has been "fettled" every Friday in every home ever since the day it was invented.

* * *

A new Department of Light has been opened at the National Physical Laboratory. Complete with black-out curtains?

* * *

Remarks overheard in the train the day after the Budget speech.

One workman, to his mate: "Well, wot's a penny a pint on beer, anyway? After tha's 'ad a few pints, tha'll never notice t'difference in price!"

"What with postage at 2½d. it will soon be cheaper to marry the girl."

* * *

A notice outside a village hall stated that a meeting was to be held to discuss the possibilities of carrying on the cricket club this season. Some members, it is feared, would drop out owing to the increased price of matches.

* * *

Apropos of the increased postal rates, it is a hundred years ago almost to the day that the penny post was introduced. Did Rowland Hill manage to pull it off as easily as Sir John Simon has managed to put it on?

"MARKSMAN."

Machining Allowances on Castings

FOUNDRY AND MACHINE-SHOP ANGLES COMPARED IN A YORKSHIRE DISCUSSION

Filling in a meeting date which, but for war conditions, would have been devoted to a works visit, MR. S. W. WISE, hon. secretary of the West Riding of Yorkshire Branch of the Institute of British Foundrymen, kindly stepped into the breach by initiating a discussion on machining allowances on castings. The actual Paper read by Mr. Wise had been given under this title to the Keighley Association of Engineers on November 22, 1930, and was reported in a subsequent issue of THE FOUNDRY TRADE JOURNAL. It was, of course, written originally with the definite idea of presenting the foundryman's point of view to engineers on a question always liable to be the cause of difficulty between the two sections.

Addressing himself essentially to foundrymen, Mr. Wise said the question of machining allowance was so open to differences of opinion that it would be difficult to provide for a definite standard of allowance. Methods of patternmaking, founding and (he believed) machining varied so much, not only in different parts of the country, but very considerably in a locality.

There was no doubt the foundryman often felt that the people who had to handle the castings subsequently did not always realise fully the many varying factors associated with founding. Possibly, on the other hand, foundrymen themselves were too ignorant of the many pitfalls met with during machining processes. For that reason he had addressed an engineering society in the hope of helping towards a closer mutual understanding between the two branches of the engineering industry.

Two Points of View

The particular phase of machining allowance, of course, formed a definite link between machine shop and foundry, and the amount of consideration shown by one branch inevitably lightened the burden of the other. It was sometimes forcibly expressed by the machinist that the founder put extra material on his castings in order to ensure that potential defects were removed during machining. The founder declared, with equal candour, that it was put on to give the machinist plenty of material to play with—perhaps, at the back of his mind, he had an idea that it was possible to err in the setting up of a job.

However it might be expressed, all must agree that some allowance was necessary, and opinion would vary only as to the amount under certain conditions. It was axiomatic in most operations that some extra material must be left on for subsequent removal, and the cost of appliances, or of the operation itself, rose rapidly with the decrease in amount of material to be removed, and the degree of accuracy required.

The lecturer suggested that one might follow a particular article through the various stages—from the pencil sketch to the finished drawing, on to the pattern and corebox. The manner of production depended on cost and expediency, and he detailed the processes undertaken by the founder, in varying circumstances, to meet these factors, compatible with accuracy of product. Every advancing step was taken with the object of securing closer conformity to design in all subsequent operations, but this advancement necessarily carried increased costs according to the method employed. He went on to show how similar conditions applied in the foundry—and, in the original Paper, had described the processes in detail. The object of any method was ultimately the elimination of dimensional variation, with the assumption that the increased expenditure might be justified.

Machine-Shop Conditions

Assuming the casting to have passed to the machine shop, the lecturer reviewed the treatment there, beginning with the steps for removal of the surplus material. The machinist, also, must have latitude. The removal would not be all in one stage. After each stage the casting would carry material allowance for the next stage in order to facilitate work at subsequent stages. Roughing cuts would be followed by finishing cuts. These might lead to grinding, but safeguards would be left in surplus material to ensure ultimate accuracy. Even the erector, assembling the casting in correct position, might need an allowance to be made for his share of the work in the form of chipping strips. This information might sound elementary, said the lecturer, but it was as well in a discussion of this sort to have minds refreshed on even everyday procedure, and to emphasise that the need for allowances at every stage was not confined to the foundry alone.

Allowances could be kept to a very fine margin in an engineering works which had its own foundry, and where drawing office, patternshop, foundry and machining department all worked in close co-operation and in an atmosphere suitable for the development of the team spirit. These conditions approached the ideal, and indications were that more and more in the future this spirit would be fostered. When, however, castings were bought from outside works—from, say, the competitive founder—differences could not so easily be adjusted, and there was a definite call for a spirit of toleration which was not always evident.

Economic considerations forced the founder to submit sometimes to limitations imposed by the buyer, very often against his own better judgment. Under these conditions an allowance certainly was granted, but it was inclined to be a grudging indulgence. The founder might not even be consulted at all as to amount of material to be left for machining. Consideration was sometimes withheld until after trouble had arisen.

Insufficient Allowances

Mr. Wise said he had stressed to the engineers the point—which sometimes did not appear to be appreciated—that an insufficient amount of machining allowed on a casting might cause as much trouble, or more, as if there were an excess. The widespread notion that the founder was out for increased metal to add price if he was selling by weight was far from the truth. Many foundrymen must have experienced cases in which it would have been to their advantage if the amount of metal surplus had been less. In some cases the founder was to blame in not giving adequate time and thought to the situation—in accepting orders without clearly understanding the purposes for which the casting was intended, or working from patterns sent to him, with little regard as to machining allowed, and his interest was not aroused until he got a debit note for defective work for which he was perhaps not entirely to blame.

Influence of Foundry Conditions

The lecturer then proceeded to review details as to varying methods in different foundries, and even in the same foundry at different periods, owing to changing circumstances, requirements and particular needs affecting the ultimate product. The type of work generally made in a particular shop, the class of tackle available, the volume of work going through at the time, core stove accommodation, special experience of the workpeople involved, and other factors were quoted as explaining this seemingly illogical situation.

Founding, rather than being as yet perhaps an exact science, was in many opinions an intelligent averaging of variables owing to the number of factors not under control. Mr. Wise gave a series of illustrations of these variable factors, quoting certain castings and the founder's difficulties and operations in producing them in an endeavour to meet the ultimate requirements of the buyer, whilst ensuring adequate machining allowance for all probable subsequent processes.

The apparently simple cylindrical casting could be made in a variety of ways and was full of possibilities of error, calling for special consideration depending on the method of moulding and its dimensions. With a fairly large one made by strickling, with loose lugs bedded in, an allowance of $\frac{1}{4}$ in. a side was not too much to ensure its being dimensionally accurate. If made from a pattern and corebox under normal conditions, $\frac{1}{8}$ in. a side might suffice; or if produced on repetition lines with metal patterns and moulding boxes—a toolroom job—then so small an allowance as $\frac{1}{32}$ in. a side had been known to be enough. Reducing to this very small margin, however, was liable to involve a degree of expense only justified by a very large quantity being required from the same pattern.

In addition to the plain type of cylinder, complications might be introduced in the shape of valve faces, pipe attachments, door facings and the numerous bosses frequently encountered in this class of work, all of which were subject to special care in connection with the question of surplus material. The motor-car cylinder, said the speaker, might be selected by some as one of the best examples of a complicated casting being produced with this surplus reduced to the lowest margin. It had been the subject of most careful study and co-operation between the various interests handling it.

This class of work had been responsible for the rapid development of jigs and other modern machine-shop tools, which called for a further word of sympathy for the founder. The extended use of the jig had led to the gradual elimination of the marker-off. Much thought and expense were necessary before the foundry plant and tackle could be placed at the high standard essential to the method of locating a casting into a jig with proper regard for a constant point, and it was unfair to treat a casting made under normal trading conditions as if it were the product of a foundry approaching laboratory standards.

Motor Vehicle Castings

Mr. Wise spoke of other classes of automobile parts produced under almost ideal conditions, especially pistons, valve plugs, wheels and similar units, but with the wheels which came under the attention of the jobbing or general foundry the position was vastly different, and the need for varying the machining allowance was very much in evidence. Most wheels, from the point of view of moulding, were simple affairs, but their size, construction or the service for which they were intended might be the reason for widely different treatment. He gave instances of these differences, and the varying treatment required.

Another class of castings cited as involving widely variable conditions and productive methods was that of the box or hollow form of casting, such as housings, casings, etc. Most of the reasons for differential treatment already mentioned applied also in these products, but there was another which was perhaps not so

commonly encountered. When a mould was made up of several horizontal parts, there was a tendency to increase in size owing to gaining a little at the joints, and it was the practice on these occasions to anticipate the risk of error by the use of a standard rule instead of one for contraction.

A further trouble was that the increased popularity of the grinding method of removing surplus material had brought a demand for the reduction of surplus; and whilst this could readily be met on the underside of the casting, it was not, for obvious reasons, so easy dealing with the top side. The founder, however, must fit himself into modern developments, and it was essential that he should be equipped with first-class patterns, moulding boxes and other essentials—a factor which was not always given the same attention by directorates as care and upkeep of the tools in a modern machine shop. As more thought and money were expended on foundry equipment, and the mental attitude in the foundry towards innovations approached the ideal of the Institute, so the products of the foundry would require less and less attention from the machinist.

DISCUSSION

The BRANCH-PRESIDENT (Mr. S. Carter) voiced the thanks of the members to Mr. Wise, their hon. secretary, for filling a breach on an occasion which had been expected to be a works visit. Mr. Carter asked Mr. Wise what machining allowance he would consider satisfactory from the points of view of both the founder and the engineer for large cylindrical castings made in loam sand, about 30 in. dia. by 5 ft. long, cast on end, machined at both ends.

MR. WISE in reply suggested an allowance of $\frac{1}{4}$ in. up the bores and on the bottom face, and $\frac{3}{8}$ to $\frac{1}{2}$ in. on the top flange.

MR. CARTER, referring to the strickling of green-sand wheels of 4 to 5 cwts. each, poured from the boss, asked what would be a reasonable machining allowance on the top face.

MR. WISE thought that $\frac{1}{4}$ in. on the top face and $\frac{1}{8}$ in. on the bottom would be adequate.

MR. W. H. THORNTON (Past-President), mentioning difficulties in connection with various castings he had handled, said in his own experience castings of different shapes and sizes differed in contraction, and it had been necessary to use different contraction rules for varying jobs.

MR. WISE said Mr. Thornton's remarks emphasised the main point of the Paper—that it was impossible to lay down standard rules for contraction because there were not standard rules for casting. He recalled some very curious experiences of his own in contraction. Contraction rules, to his mind, were most unreliable.

MR. J. BLAKISTON, relating an experience with a line of castings weighing a hundredweight downwards, said after production had been in progress for about a week, a liability to discrepancy in the wood of the patterns owing to temperature was detected. The core plate also tended to warp.

Wood Patterns and Warping Tendency

MR. THORNTON said he would be very chary of working with wood patterns, which were always liable to warp, not only on account of temperature, but also by contact with the wet sand.

MR. H. FORREST disagreed that wood patterns must necessarily be expected to warp. When making large numbers of castings day by day the machine shop had a right to expect the minimum of machining and the maximum of good castings. In his own experience, in making pistons, he found there was a difference in the amount of drying-in, and the difficulty was overcome by using a hardwood boiled in paraffin wax. There was, he found, less danger of trouble with wood core boxes when using oil sand, but he did not consider wooden boxes at all ideal for quantity production. When core-blowing machines were used, they were liable to be destructive to the boxes, whether in wood or metal. It was not the fault of the machines so much as the greater frequency of use of the boxes, and therefore they required extra care. In many cases it would help the founder if the patternmaker would indicate more clearly on his pattern which were the places that must be clean, or whether it was required to be a fine limit.

MR. WISE pointed out that in the South and Midlands the custom was to paint the different parts with different colours. There had been much improvement since the Institute of British Foundrymen had made definite recommendations.

MR. COPELAND suggested that the error might be due to conditions in the foundry itself, and not always to the core boxes.

The Borings Problem

MR. F. OLDERSHAW remarked that nothing had been said about borings. In a big shop there was a big accumulation of borings, and a lot of money was being lost in regard to their disposal. The heavier the machining the greater the quantity of borings, and that added to the cost. This was a big point and must have an effect on the ultimate cost of the product. Machining allowance should be kept down as far as possible on that ground.

MR. WISE, agreeing, said his plea was for a spirit of toleration between founder and machine shop. In some classes of work the borings weighed more than the casting itself.

MR. BLAKISTON said the remedy for that was not to sell castings on a tonnage basis.

MR. FEARNSIDES said that facings and camber seatings caused a good deal of trouble to the jobbing foundryman, who was doing work not known from day to day, as distinct from the man engaged on repetition work. The jobbing founder was the man who needed some tolerance in machining allowance.

MR. A. W. WALKER (Past-President) summed up the situation by saying that Mr. Wise was urging proper co-operation between pattern-shop, founder and machine shop, and in that plea he entirely agreed with him.

Vote of Thanks

MR. H. A. MACCOLL, moving a vote of thanks to Mr. Wise, seconded by MR. FEARNSIDES, complimented him on producing a Paper which was originally framed for presentation to a society of engineers and yet was equally acceptable to a meeting of foundrymen, in spite of their substantial differences of outlook. To the foundryman, the engineer often seemed very illogical in his requirements, and the case presented in the Paper was one which could not be too strongly stressed on engineers.

(*Continued from third column.*)

author has overlooked the fact that high-duty cast-iron blades, being homogeneous, are now used with considerable success. This section also contains a table of common troubles experienced with airless equipment, together with causes and suggested remedies.

The concluding section gives some very helpful information regarding ventilation and dust removal. A very interesting and useful tabulation of French and German translations of English technical terms is given at the end of the book.

To the foundryman, shot-blasting is an extremely important process; its efficiency depends very much on correct setting and effective maintenance. Foundrymen will find this book very helpful both in the care and maintenance of their equipment and in the selection of new plant.

E. HUNTER.

Book Reviews

The Corrosion of Iron and Steel. By J. C. Hudson, D.Sc. Published by Chapman & Hall, Limited, 11, Henrietta Street, London, W.C.2. Price 18s. net.

The Corrosion Committee of the Iron and Steel Institute and the British Iron and Steel Federation published the results of their important and painstaking work in five volumes, costing 16s. each (to members of the Iron and Steel Institute, 10s. each). These reports will long remain standard works of reference, but they necessarily contain a great deal of detail, and the criticism that they are too detailed and too bulky to enable the practical man to pick out the essential data which he requires may be well founded.

In this present volume Dr. Hudson presents a *résumé* of the Committee's work in a form intended particularly to appeal to those who wish to apply its results.

Chapters dealing with the significance of rolling scale in the rusting process, the rusting of unprotected iron and steel in the atmosphere, and the prevention of rusting by means of paint, are particularly informative, and form a remarkably concise and readable *résumé* of the original reports.

Chapter VI, dealing with protective coatings for iron and steel, has a general practical appeal, whilst Chapter VII will appeal particularly to shipbuilders.

Although in the introduction it is stated that Dr. Hudson had been invited to write a popular book, and he has succeeded in doing so, he has at the same time produced a high-grade technical work which cannot fail to be of interest to a wide class of reader. The book is well produced, but the publishers have been unfortunate in their choice of a paper jacket which gives the work the appearance of a novel.

J. FERDINAND KAYSER.

Impact Cleaning. By William A. Rosenberger. Published by the Penton Publishing Company, Caxton House, Westminster, London, S.W.1. Price 39s.

In compiling this 466-page book, the author has gone to considerable pains to present a very comprehensive survey of impact cleaning. The book is intended for designers and manufacturers as well as users, and in consequence it contains a quantity of technical data and formulæ which to the foundryman will be of academic interest only. The author has a very easy style and presents his facts carefully and logically, taking care not to overstate.

The book is set out in three parts, the first dealing with air-blast cleaners. In this part the author goes to some length to show how to obtain maximum efficiency, the correct set of nozzles, angle of impact and velocities being fully discussed, whilst some very useful hints are given for reducing wear. This section also contains in tabulated form the troubles most common to users of air-blast equipment, together with causes and suggested remedies. Pre-coolers and other means of moisture separation receive detailed consideration, whilst such subjects as steam and water blast are also included in the first part of this volume. A chapter dealing with compressed-air lines concludes the first section.

Airless impact-cleaning equipment is the subject matter of the second part of the book. Here the author discusses the relative advantages and drawbacks of this type of equipment. The type of work most suited to mechanical cleaning is also dealt with, this information being extremely useful to a prospective purchaser of new equipment.

On page 283 the author suggests that it is not possible to produce vanes of uniform quality from a cupola and that they should be made from an electric furnace. Possibly the

(*Continued at foot of previous column.*)

Influence of Ladle Additions on the Properties of Cast Iron

By E. PIWOWARSKY

Translation (abridged) from "Die Giesserei."

The large proportion of steel scrap employed in most processes using ladle additions suggests that the results obtained are ascribable not so much to the ladle additions as to the considerable steel additions in general, and to the consequent lowering of the carbon content. Emmel[1] gave values for the tensile strength averaging 19 tons per sq. in. for a number of cast-iron melts with carbon contents of between 3.0 and 3.5 per cent., melted by his steel addition process. In the Meehanite process, total carbon contents as low as between 2.4 and 2.7 per cent. are generally attained, so that the above assumption would appear to be quite justified.

The object of the work described in this Paper was to assist in clearing up this problem. It was not the intention to ascertain what kinds of ladle addition and what amounts exercise the best effect on the mechanical properties of the iron, but the object was rather to ascertain what changes in structure are produced in a series of high-carbon and low-carbon melts by means of the most usual ladle additions, such as ferro-silicon, calcium-silicon, titanium-silicon and calcium-lithium, and in what direction such additions affect the mechanical properties. Since the cupola is still the most usual melting furnace even for the production of high-grade cast iron, it was decided to employ this furnace for carrying out the principal experiments. Preliminary informative experiments were made with cupola iron treated in the electric furnace.

EXPERIMENTAL WORK

Experiments with Cast Iron Electrically Refined

The casting of electric furnace iron was carried out in the foundry of Hartung-Jachmann A.-G., Berlin-Borsigwalde, where the duplex process is employed. The programme of the melts and the nature of the ladle additions are shown in Table I. According to this programme, it was intended to investigate the behaviour of an addition of ferro-silicon in the melting furnace (electric furnace) in comparison with corresponding additions of ferro-silicon or calcium in the ladle. Series I comprises melts with about 3.2 to 3.3 per cent. C. and about 1.5 per cent. Si, while Series II comprises melts of lower carbon content (2.8 to 2.9 per cent.) and about 2 per cent. Si.

A basic electric furnace was used, power at 6,000 volts being supplied to the primary of a 1,600-kw. transformer which reduced it to a working pressure of 180 volts. During the refining of the melt, the electrical connections were switched over from delta to star with a secondary pressure of 112 volts. The cupola charge was made up of hematite scrap, machine scrap, special scrap, "silver" iron* and steel scrap with an addition of 1.8 per cent. (Heat I) and 3.9 per cent. (Heat II) of 75 per cent. ferro-silicon. The weight of a charge was 500 kilograms (10 cwts.). The iron tapped from the cupola had a carbon content of about 3.3 per cent. C. In the case of Heat II, the carbon content was subsequently lowered in the electric furnace by the addition of steel scrap. In each case, the proportion of scrap in the cupola was 15 per cent. In the case of Heat I, eleven 10-cwt. charges were melted down, and in the case of Heat II only nine. Altogether, Heat I consisted of 5.5 tons of molten cupola charges, while Heat II amounted to 4.5 tons. Before the cupola iron was run into the electric furnace, it was always desulphurised by means of Walter briquettes, and after standing for a short time in the ladle, the slag was stiffened and skimmed off. A slag of lime, fluorspar and coke in the proportions of 12:4:1 was used in the electric furnace. In the latter, Heat I was furthermore alloyed with 25 kilograms (55 lbs.) of 80 per cent. ferro-manganese, and Heat II with 28 kilograms (62 lbs.). After remaining about 2 hours in the electric furnace, the melts were ready for pouring. Casts 1 and 2 and 4 and 5 were first taken from the melts, treated in the ladle with ferro-silicon or calcium-silicon, then the silicon content of the remainder of the melt was increased in the furnace, and after another 15 minutes, casts 3 and 6 were taken from the furnace. The weight of each casting was 250 kilograms (5 cwts.). The amount of slag produced was 2.8 to 3.2 per cent. of the molten iron.

The remainder of the melts left after taking the iron for these experiments was employed for normal production. The temperature of the iron taken from the electric furnace was determined by means of a Holborn-Kurlbaum pyrometer, and was controlled by means of a Bioptix instrument. Tapping and pouring temperatures were kept constant in the scope of each heat

* Pig-iron and steel mixed liquid and then cast.

TABLE I.—*Composition of the Six Melts of the Experimental Programme.*

(Required compositions: Heat I: 3.3 per cent. C, 1.5 per cent. Si. Heat II: 2.8 per cent. C, 2.0 per cent. Si.)

Heat	Cast no.	Composition of melts in electric furnace before addition of Si. Per cent.	Addition of Si in ladle.	Addition of Si in electric furnace.
I	1	3.3 C, 1.0 Si	0.5 per cent. Si in form of 75 per cent. ferro-silicon	—
	2	3.3 C, 1.0 Si	0.5 per cent. Si in form of 66 per cent. calcium-silicon	—
	3	3.3 C, 1.0 Si	None	0.5 per cent. Si in form of 75 per cent. ferro-silicon.
II	4	2.8 C, 1.5 Si	0.5 per cent. Si in form of 75 per cent. ferro-silicon	—
	5	2.8 C, 1.0 Si	0.5 per cent. Si in form of 66 per cent. calcium-silicon	—
	6	2.8 C, 1.0 Si	None	0.5 per cent. Si in form of 75 per cent. ferro-silicon.

TABLE II.—*Superheat and Pouring Temperatures.*

Heat.	Cast no.	Tapping temperature. Deg. C.	Pouring temperature. Deg. C.
I	1	1,520	1,330
	2	1,520	1,330
	3	1,520	1,330
II	4	1,480	1,375
	5	1,480	1,375
	6	1,480	1,375

TABLE III.—*Complete Percentage Analyses of the Six Melts.*

(Actual analyses.)

Heat.	Cast no.	T. C.	Si.	Mn.	P.	S.	Gr.
I	1	3.2	1.55	0.86	0.5	0.023	2.18
	2	3.2	1.80	0.84	0.5	0.02	2.35
	3	3.2	1.63	0.88	0.5	0.02	2.20
II	4	2.86	1.95	1.10	0.2	0.034	2.01
	5	2.86	1.90	1.06	0.2	0.028	1.95
	6	2.88	2.10	1.02	0.2	0.021	2.04

TABLE IV.—*Individual and Mean Values of Transverse Tests. (Separately-cast Bars.)*

Heat.	Cast no.	Transverse strength. Kgs. per sq. mm.		
		1.	2.	Average.
I	1	48.5	49.5	49.0
	2	46.5	48.5	47.5
	3	46.0	48.0	47.0
II	4	61.5	58.5	60.0
	5	60.0	55.0	57.5
	6	57.8	56.2	57.0

TABLE V.—*Tensile Strength of 24 Test-Pieces taken from the Bars.*

(Taken from the ends of the transverse bars.)

Heat.	Cast no.	Tensile strength k_g. Tons per sq. in.				
		1.	2.	3.	4.	Average.
I	1	19.5	19.5	20.0	20.2	20.4
	2	19.2	19.2	19.8	20.0	19.6
	3	19.2	19.0	19.0	19.5	19.4
II	4	22.5	23.7	20.4	22.5	22.2
	5	22.8	20.4	23.5	22.3	22.2
	6	20.4	22.8	20.9	24.1	22.1

TABLE VI.—*Tensile Strength of Test-Bars from the Castings of Different Wall Thicknesses.*

Heat.	Cast no.	Tensile strength k_g.		Tons per sq. in.	
		20 mm.	40 mm.	60 mm.	80 mm.
I	1	15.5	15.7	14.7	14.1
		15.5	15.7	13.8	14.
	2	16.6	16.0	15.2	13.6
		16.2	17.1	14.0	13.3
	3	16.0	14.8	14.1	14.3
		15.1	16.0	12.1	13.8
II	4	20.0	19.7	18.5	15.9
		19.7	19.5	*	*
	5	18.6	20.4	17.5	18.4
		20.5	20.5	*	*
	6	19.0	17.5	16.8	17.5
		20.4	18.6	16.0	†

* Defective. † Cavity.

TABLE VIII.—*Tapping Temperatures of the Melts.*

Series.	Melt no.	Temperature of iron. Deg. C.				Mean tapping temp. Deg. C.
		1st tap.	2nd tap.	3rd tap.	4th tap.	
I	11	1,345	1,385	1,410	1,445	1,396
	12	1,425	1,410	—	—	1,418
	13	1,400	1,410	—	—	1,405
	14	1,435	1,435	1,430	—	1,433
II	24	1,435	1,455	1,480	1,500	1,467
	25	1,460	1,510	1,490	1,500	1,490
III	21	1,460	1,460	1,470	1,470	1,465
	22	1,470	1,450	1,460	—	1,460
	23	1,425	1,415	1,415	1,425	1,420
	L	1,445	—	—	—	1,445

(Table II). Table III gives the analyses of the individual casts. At each cast, four normal transverse test-bars (bottom cast, on end, 30 mm. (1.1 in.) dia., 650 mm. (25.5 in.) long) and a box-shaped hollow casting of 20, 40, 60 and 80 mm. (0.78, 1.5, 2.3 and 3.1 in.) section thickness were poured in each experiment. The moulds were always dried and blacked. Figs. 1 to 3D show the sectioning of the box-shaped casting for producing the test-bars. The short tensile test-bars (Figs. 3A to 3D) were obtained from the section of 85 mm. (3.34 in.) height, utilising the entire wall cross-sections (Fig. 1), while metallographical specimens, hardness test-pieces and shear test-pieces were taken from the section of 30 mm. height (designated S, B and S′ in Fig. 4). Plates 1.6 mm. (0.06 in.) thick, 19.8 mm. (0.77 in.) wide and of a length corresponding to the wall thickness were employed for the shear tests by the Hugo and Piwowarsky method.

The results of the transverse and tensile strength tests are given in Tables IV to VI. It will be observed that both types of iron are to be regarded as definitely high grade. The material treated in the electric furnace is, however, scarcely inferior to that treated in the ladle. There were also scarcely any differences between the effect of ferro-silicon and that of calcium-silicon.

Primary etchings (with boric acid and concentrated sulphuric acid) of 42 polished specimens taken systematically from the castings showed that casts 1 and 2 and also 4 and 5 solidified with somewhat more pronounced supercooling, since they exhibited more numerous, but shorter, dendrites than the corresponding specimens of casts 3 and 6. Furthermore, in the box-like castings, the length of the dendrites increased with increasing wall thickness, *i.e.*, supercooling decreased with increasing wall thickness. The values for the shear strength (not reproduced) corresponded in general to the relationship $\sigma_B = (\tau_z - 7)$. 1.08 previously discovered by Hugo and Piwowarsky. The ratio of shear strength : tensile strength increased with increasing tensile strength, approaching unity for casts of high mechanical strength. The hardness also mainly followed the previously discovered relationship $H - 40 = 5.16\,\tau_z$.

Three principal series of experiments, differing mainly in the make-up of the charges and the working of the cupola, and in the resulting carbon contents, were carried out in the experimental cupola of the Aachen Foundry Institute (Fig. 5). The melts of each series differed in their after-treatment with different ladle additions.

In the first series, comprising melts 11, 12, 13 and 14 (see Table VII), the charges consisted almost entirely of pig and grey-iron scrap, with a proportion of steel of only 11 per cent. The carbon contents were all above 3.3 per cent.

The second series (melts 24 and 25) was melted with 62 per cent. of steel scrap, and the carbon content was increased to above 3.3 per cent. C in the furnace by employing coke of smaller size with a lower rate of melting and longer stay in the furnace. Tapping was effected at intervals of about twice the length of those of the first series of melts.

The third series (melts 21, 22 and 23) differs from the second series only in the lower carbon content, which was at the most 2.8 per cent. C. The increase in carbon content to a maximum of 2.7 per cent. C taken as basis for the calculations was found on analysis to be tolerably accurate.

In order to complete previous work carried out in the Foundry Institute of the Aachen Technical School on the influence of lithium upon high-carbon iron melted solely from pig, where it was not possible to detect any appreciable influence on the mechanical properties, a low-carbon melt from a charge, containing over 50 per cent. steel scrap, was finally treated in the ladle with calcium-lithium.

The cupola plant employed has been described

TABLE VII.—*Chemical Composition and Mean Values of the Mechanical Properties of all the Cupola Melts.*

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
		Ladle addition.		Chemical composition.										Mean values of mechanical properties.												
Series.	Melt no.	Alloy.	Per cent.	T.C. Per cent.	Gr. Per cent.	C.C. Per cent.	C + Si. Per cent.	Si. Per cent.	Si from charge. Per cent.	Si from ladle addition. Per cent.	Si. Per cent.	Mn. Per cent.	P. Per cent.	S. Per cent.	Added element.	Mean spout temp. Deg. C.	Transverse strength Kg./mm.²	Deflection. Mm.	Tensile strength. Tons per sq. in.	Brinell hardness.¹ 10/3,000/30.	Shear strength. Kg./mm.²	Impact strength.² Normal. Kg./mm.²	Corrected according to Le Chatelier. Kg.mm./cm.²	Minimum impact work. Kg./mm.²	Wear (loss in grms.) On steel.	Wear (loss in grms.) On cast iron.	Shrinkage. Per cent.
I	11	Fe–Ti (23%) Fe–Si (93%) Ca–Si (30% Ca, 60% Si)	Ti : 0.25 Si : 0.40 Ca–Si : 0.75	3.67	3.04	0.63	4.51	0.84	0.81	0.03	0.93	0.63	0.16	0.087	Ti : 0.036	1,396	43.9	15.5	11.5	149 to 136	21.2	0.41 / 0.59	0.33 / 0.55	0.18 / 0.34	0.57	0.38	0.91
	12			3.50	2.88	0.62	4.44	0.94	0.81	0.13	0.88	0.80	0.15	0.047	Ca–Si	1,418	39.1	10.8	13.5	162 to 154	21.0	0.37 / 0.49	0.27 / 0.44	0.20 / 0.39	0.64	0.21	1.06
	13	Fe–Si (96%) No ladle addition	Si : 0.70	3.67	2.97	0.70	4.93	1.26	0.81	0.45	0.94	0.80	0.165	0.078	Fe–Si	1,405	33.4	11.2	10.5	151 to 137	18.8	0.36 / 0.58	0.26 / 0.54	0.20 / 0.34	0.63	0.20	1.10
	14		—	3.65	3.02	0.63	4.68	1.03	—	—	0.92	0.67	0.165	0.070	—	1,433	38.4	12.3	11.0	152 to 139	20.3	0.45 / 0.65	0.38 / 0.60	0.17 / 0.35	0.58	0.28	0.85
II	24	as 13	as 13	3.32	2.53	0.69	5.03	1.81	not determined	0.03	0.86	0.65	0.190	0.141	Fe–Si	1,467	48.8	11.4	14.5	173 to 164	23.9	0.35 / 0.75	0.24 / 0.72	0.20 / 0.45	0.52	0.13	1.20
	25	as 14	—	3.60	2.74	0.86	5.00	1.40	not determined	0.13	0.93	0.84	0.065	0.093	—	1,490	45.6	11.8	13.2	160 to 153	22.6	0.39 / 0.71	0.31 / 0.68	0.16 / 0.39	0.59	0.21	1.14
III	21	as 11	as 11	2.75	2.05	0.70	4.18	1.43	1.09	0.34	0.71	0.82	0.165	0.030	Ti : 0.035 Ca–Si	1,465	58.1	13.2	20.2	206 to 183	31.4	0.36 / 0.83	0.25 / 0.80	0.20 / 0.48	0.34	0.05	1.03
	22	as 12	as 12	2.56	1.75	0.81	4.00	1.44	1.09	0.35	0.66	0.70	0.135	0.070		1,460	51.9	9.1	20.0	215 to 197	32.3	0.38 / 0.76	0.29 / 0.73	0.20 / 0.58	0.24	0.04	1.16
	23	as 14	—	2.48	1.79	0.69	4.73	2.25	not determined		0.68	0.42	0.070	0.068	—	1,430	45.6	8.6	16.9	255 to 226	—	—	—	—	0.60	0.05	1.26
	L	Ca–Li alloyed with Pb	Ca–Li : 0.1	2.52	1.57	0.95	4.63	2.11	not determined		0.69	0.51	0.060	0.055	Ca–Li	1,445	42.1	7.6	15.1	In 30-mm. round bar 291	—	0.35 / 0.60	0.25 / 0.56	0.16 / 0.45	0.41	0.05	—

¹ First value determined on the 20-mm. step of the stepped wedge, the second value on the 80-mm. step.
² Upper value for notched test-pieces. Lower value for unnotched test-pieces.

previously in "Die Giesserei,"[3] and no important alterations have been made since then (see also Fig. 5).

The furnace has six tuyeres situated in a horizontal plane. Of these, only two diametrically opposite tuyeres were employed, the pressure of the blast being 650 mm. (26.7 in.) water gauge. The volume of air was about 18 cub. metres per min. (631 cub. ft.). On account of the rather bulky steel scrap, a weight of charge of about 70 kgs. (150 lbs.) was selected.

In order to eliminate the influence of any slag floating on the surface of the ladle contents and to prevent premature combustion of the ladle additions, use was made of the teapot receiver shown in Fig. 5.

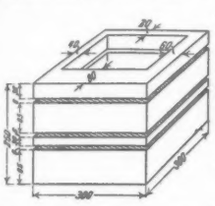


FIG. 1.—DIMENSIONS OF BOX-LIKE HOLLOW CASTING.

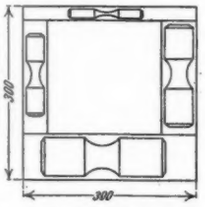


FIG. 2.—ARRANGEMENT OF TENSILE TEST-BARS IN BOX-LIKE CASTING.

When the ladle additions were introduced into the part of the teapot receiver nearer the furnace, it was found that the suction effect produced while the metal was being run off caused them to be drawn immediately to the bottom, so that they were removed from the action of the atmospheric oxygen. The quantity of ladle additions was designed to be such as to correspond approximately to the graphitising action of 0.6 to 0.8 per cent. Si.

In the case of Series I, the amount of coke was always 12 per cent. of the iron charged, about 0.5 per cent. of which was consumed for carburising. In the case of Series II, the amount of coke had to be increased to 14 per cent. in view of the requirement of about 2 per cent. for carburising. The amount of slag-forming materials added in each case was 30 per cent. of the weight of the coke. The analysis of the coke was 88.43 per cent. C, 0.85 per cent. S, and 8.78 per cent. ash.

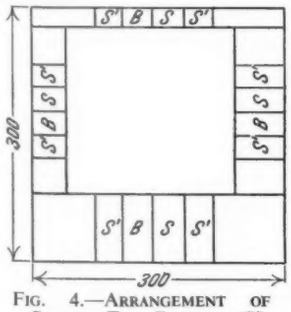
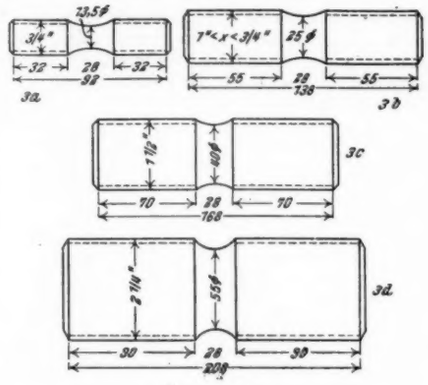


FIG. 4.—ARRANGEMENT OF SHEAR TEST-PIECES (S'), BRINELL HARDNESS TEST-PIECES (B), AND METALLOGRAPHICAL SPECIMENS (S) IN THE BOX-LIKE CASTING.

The melting capacity of the furnace had an average output of 850 kilograms (16½ cwts.) per hr. Tapping and pouring temperatures were determined by means of a "Pyropto" radiation pyrometer, the spout temperature being taken at the end of the stream before the metal ran into the ladle, and the pouring temperature was taken on the oxidised surface of the bath in the ladle, after skimming off the slag, and on the pouring jet. The rules laid down by Rheinländer[3] and Hase[4] were followed very closely. As was to be expected, the materials melted with a high steel addition all had higher tapping temperatures than the others[2] (see Table VIII).

The quantity of about 210 kgs. (4 cwts.) of molten iron required for one set of tests was collected in a crane ladle from a number of tappings, and the additions were only made upon the last tapping, after the ladle and teapot receiver had been completely freed from slag, in order to prevent the latter from enveloping the addition and rendering it ineffective.



FIGS. 3A-D.

To melt 11 there was added 0.25 per cent. Ti in the form of 23 per cent. ferro-titanium. A preliminary experiment had shown that this quantity was not sufficient to cause grey solidification. To avoid an inexpediently large addition of ferro-titanium, an addition of 0.4 per cent. Si in the form of 96 per cent. ferro-silicon was made at the same time.

In the case of melt 12, the graphitising effect of calcium was taken to be equal to that of silicon, and therefore the amount of CaSi added was fixed at 0.75 per cent. Melt 13 had an addition of 0.70 per cent. Si in the form of

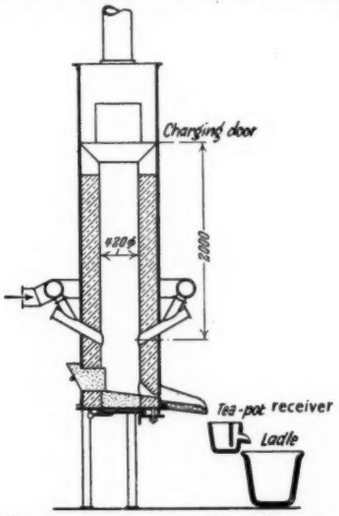


FIG. 5.—DIAGRAM OF CUPOLA PLANT.

96 per cent. ferro-silicon. Melt 14 did not receive any ladle addition. The silicon content of the furnace charge was increased by about 0.70 per cent. by means of 30 per cent. ferro-silicon. The same applies to melts 24 and 25 of the second series as to melts 13 and 14. The melts in the third series (Nos. 21, 22 and 23) were treated in the same way as Nos. 11, 12 and 14 of the first series.

The introduction of lithium into a bath of molten iron generally produces an explosive reaction, but a lead alloy addition, such as was employed in the case of melt L, merely causes the molten mass to boil up, with copious evolution of a yellow fume (lead oxide). The reaction quickly came to an end, so that it was possible to pour at substantially the same time as with the other melts.

The absorption of silicon from the ladle additions was greatest in the case of melt No. 11 (Table VII, Column 10), but even then it was only 65 per cent. of the amount added. The fact that in melts 21 and 22, the absorption of silicon was substantially greater than in melts 11 and 12, which were subjected to the same treatment, was probably due to the lower carbon concentration in the former. Only a very small proportion of the titanium introduced was found in the analysis.

REFERENCES.

[1] G. Meyersberg: "Edelguss" (Verlag Julius Springer, Berlin, 1929), p. 85.
[2] E. Piwowarsky and K. Achenbach: "Giesserei," 25 (1938), p. 74.
[3] P. Rheinländer: "Giesserei," 15 (1928), p. 911.
[4] R. Hase: "Arch. f. Eisenhüttenwes.," 5 (1931-1932), p. 267.

(*To be continued.*)

Patent Specifications Accepted

The following list of Patent Specifications accepted has been taken from the "Official Journal (Patents)." Printed copies of the full Specifications are obtainable from the Patent Office, 25, Southampton Buildings, London, W.C.2, price 1s. each. The numbers given are those under which the Specifications will be printed and abridged, and all subsequent proceedings will be taken.

517,928 SOC. ANON. DES HAUTS FOURNEAUX ET FONDERIES DE PONT A MOUSSON. Process and means for the bending of pipes, bars, plates, and like pieces.

517,963 BRASSERT & COMPANY, LIMITED, H. A. (Brassert, H. A.). Supply of blast to blast furnaces.

517,998 LATTRE, P. DE. Process of pickling iron and its alloys.

518,089 BRITISH FURNACES, LIMITED (Surface Combustion Corporation). Production of malleable iron.

518,132 GENERAL ELECTRIC COMPANY, LIMITED, JENKINS, I., and WILLIAMS, S. V. Bright annealing alloys of the type containing a constituent volatile at the annealing temperature.

518,179 GATHMANN, E. Ingot moulds and ingots, and method of producing ingots.

518,203 LONGENECKER, L. S. Method of firing open-hearth furnaces for melting and refining metal.

518,077 BRUCE, J. Supply of pulverised fuel and air to furnaces.

518,212 STEWARTS AND LLOYDS, LIMITED, and DICKIE, H. A. Manufacture of steel.

518,261. WESTBERG, S. Production of refined iron and alloy steels.

518,316 DODERER, W. Annealing furnaces.

518,350 TRAUT, R. Apparatus for continuously covering or coating metal tubes with a bituminous protective coating which is liquid when hot.

518,440 GOLDSCHMIDT, V. M. Refractory blocks for the construction of furnaces.

518,469 CLAY CROSS COMPANY, LIMITED, JERVIS, F., JERVIS, G., and WATTS, J. Method and means for the introduction of powdered material into tubular bodies such as casting moulds, pipes, or the like.

518,495 SHORTER PROCESS COMPANY, LIMITED. Methods of and apparatus for the surface heat-treating or hardening of metal bodies.

518,570 STERN, H. Treatment of alloy steel scrap.

518,726. COWAN, R. J. Case-hardening of ferrous articles.

518,762. BRASSERT & COMPANY, LIMITED, H. A., BRASSERT, H. A., and COLCLOUGH, T. P. Manufacture of iron.

518,831. MONZER, A. Process of and apparatus for the intimate combining of steel and non-ferrous metal.

518,871. VICKERS-ARMSTRONGS, LIMITED, and CLIFTON, J. C. Apparatus for testing the hardness of materials.

518,884. METALLISING ENGINEERING COMPANY, INC. Making negatives in metal of metal objects of substantially-smooth surface.

518,900. ENDRES, G. Anti-rusting solutions, and methods of preparing the same.

518,921. FREYN ENGINEERING COMPANY. Tuyeres.

518,986. LOBLEY, A. G., and BIRMINGHAM ELECTRIC FURNACES, LIMITED. Means for controlling temperatures in furnaces and similar apparatus.

E

[2] Upper value for notched test-pieces. Lower value for unnotched test-pieces.

Control Aspects in the Repetition Foundry*

By A. B. BILL

Castings produced in the repetition foundry, particularly those for the motor-vehicle or allied trades, must be delivered to exacting specifications covering dimensional accuracy, material quality and soundness. To achieve this standard, and to ensure that rejections shall not be such as to interrupt the flow through repetition machining lines, adequate supervision in the foundry and the closest control of variables are required. The fact that only semi-skilled labour can be employed demands that all tackle, every operation and all the raw materials be rigidly controlled at as many points as possible.

The vagaries of the designer are responsible for some of the awkward problems which occur in the repetition foundry, and many castings could be made simpler and more economical to produce, by slight alterations in design which would not impair their efficiency. Whilst this is a subject beyond the scope of this Paper, and one upon which a volume might be written, t least it is an illustration of the close liaison which must be maintained between the customer and the foundry to their mutual benefit.

Rectifying Complaints

Routine visits by a responsible executive must be maintained so that any changes in the detail of design can be discussed. In order to rectify complaints speedily, involving dimensional inaccuracies revealed during jigging and location, or defective material during machining, a proper record and analysis of rejects and their causes are essential.

Rejections due to unsoundness are a matter for which there is little excuse in the foundry. Providing a job is properly established before going into production and a margin of safety in feeding allowed for (particularly with regard to malleable iron or steel), it should present little difficulty. Variations can, and do, take place in melting conditions and in the resultant temperature of the metal, of course, but it is felt that laboratory control of the metal is so close, almost without exception, that the subject is hardly worth enlargement.

Efficient Pattern Equipment

The method of running should be standardised and maintained, and such denseners, risers, feeders or ties as may be necessary must become an integral part of the pattern equipment and not left to the discretion of the moulder. Efficient pattern equipment is the first essential for easy and rapid production, and the closest co-operation between pattern-shop and foundry is essential. Pattern-plates must be sufficiently strong to withstand the rough usage inevitable in the foundry. Prints must be adequate and perfectly matched, and sufficient taper allowed to ensure an easy draw. Deep cods and pockets are usually better formed by cores, and many loose pieces are easier to produce by this means. Locating cores are a more certain check for centring than mould prints, where they can be used; moreover, they facilitate moulding.

In so far as moulding practice is concerned, it would be superfluous to make extensive comment on the variety of defects which may arise from an even greater variety of causes. It would appear from the author's observation that hard ramming, sometimes of only a portion of the mould, with its consequent impermeability and inevitable blowholes or scabs, is the cause of more rejects than any other single factor. Some adaptation, therefore, of the down-sand frame is of inestimable value where it can be applied.

A regulated ramming must be used in conjunction with a sufficiently permeable and refractory sand, which should be delivered to the repetition moulder with almost foolproof characteristics. It must be sufficiently elastic to cover differences in section and running, and allow for a margin of over-ramming. Facing sand must be kept within reasonable limits of predetermined moisture content, compression strength and permeability. Coal-dust content should be constant and sufficient to prevent impermeability at the face or scabbing, and obviate sand burning into the casting and consequent cleaning difficulties.

Care with Cores

Due to the intricacies of modern design, cores play an increasingly important part in the foundry, and again it is unnecessary to comment on the actual art of core production or its methods. Each core should be inspected and gauged with as much care as the finished casting, and assemblies of two or more cores should be checked by a simple jig or gauge particularly from the angle of the danger of worn strickling faces on the corebox. In some cases it pays to locate the finished cores in a facsimile of the mould in order to ensure accuracy. The same reduction may, of course, be caused by over-rapping, and although a small core is rarely a definite cause of rejection it may form part of a machining location, and an otherwise good casting is spoilt.

Every core used should be inspected with as much care as a finished casting. Core-flash should be carefully removed, and soft undried cores rejected. Open vents and crushing cavities must be stopped off and a close clean skin insisted upon. Registers on "go-bys" should be clearly defined and intact, and dimensionally important cores which do not conform to gauge rigidly rejected.

The greatest care should be taken in locating cores in the mould and again a simple jig is of value, particularly with vertical cores forming bores. Repetition machining methods allow of so little latitude in the location of cores and the machine shop is so chary of increasing allowances to overcome discrepancies that the necessity for care cannot be over-emphasised.

Equal emphasis is placed on the necessity for the correct location of snap flasks and registering of assembly pins, box pins and brushes in order to prevent off-set castings.

Pattern equipment should be cleaned frequently to prevent loss of time in patching dragged moulds, apart from the danger of sand inclusions. Frequent inspection should be made for wear and tear or loosening of dowels and particularly it should be noted that ties and fillets so necessary to prevent shrinkage, "tearing" or cracking, have not been broken away.

In conclusion, final inspection should ensure that each casting released to the customer is, as far as can be ascertained visually, perfect within the limits usually associated with it. Clarity of outline, part numbers and general finish should be kept to a standard and a system of "go" and "not go" gauges built up to ensure accurate dimensions.

* Prize-winning entry in a Short Paper competition organised by the East Midlands Branch of the Institute of British Foundrymen.

Calling-Up Postponement Certificates

To secure postponement of calling-up for military service, application is required to be made to an Employment Exchange, and, unless there are special circumstances allowing such application beforehand, it cannot be made until after a medical examination, and must then be made within two days after that examination. That applies ordinarily, but if satisfactory reasons can be given for the delay, application may be considered if made before the day when the person concerned is ordered to present himself for service. Forms of application can be obtained from any Exchange (*e.g.*, at registration date) at any time.

A postponement certificate can only be obtained where it can be proved that exceptional hardship would ensue if the applicant were called up, and although a certificate may be issued through the Minister of Labour, ordinarily the matter is referred to a Military Service (Hardship) Committee. If the application be refused, an appeal in most cases can be made to the Umpire. An applicant can appear in person or be represented by a Trade Union official, or by a relative or personal friend, but not by a lawyer.

A certificate can be granted under three heads: (*a*) domestic position; (*b*) business responsibilities and interests; (*c*) individual circumstances and other cases (cases not covered by (*a*) and (*b*)).

In considering cases under (*a*) more consideration must be given to the circumstances in which the dependants of the applicant will be placed by the calling-up than to the applicant's individual circumstances, and a certificate is only granted if it is considered that special hardship would be caused to the dependants over and above any hardship which can be said to be present where any person is called up. Under (*b*) the authorities can only grant a certificate if the business cannot be carried on in the applicant's absence unless and until alternative arrangements are made, and that these cannot be made (or the business disposed of) immediately. Under (*c*) regard must be had to the circumstances in which the person called up will be placed if a certificate is refused, and only where there are specific circumstances which would cause more hardship than usually accompanies the calling-up of men for service will a certificate be granted.

The longest period for which a certificate can be granted is six months, although renewals for six months (or less) may be afterwards granted: but under (*b*) the maximum period including any period of renewal which can be granted is twelve months.

Future Steel Deliveries

The steel distribution scheme, which came into operation on April 8, postponed until April 29 the necessity for obtaining a departmental symbol and reference number in the case of new orders placed after April 8 and until May 31 in the case of old orders placed before April 8. We would again point out, however, that if old steel orders cannot be delivered before May 31, the contracts will require to be covered by the departmental symbols and reference numbers. Steel users should therefore make a point of examining their position and taking immediate steps to get the required symbol and reference number. Neglect in this direction will not only inconvenience consumers, but will place works in difficulty and hold up production.

FIRE HAS DESTROYED the patternshop at the Crookhall Iron Foundry of the Consett Iron Company, Limited. The foundry property and other essential buildings were untouched.

Production of Engineering Castings

VIEWS AND METHODS OF LANCASHIRE FOUNDRYMEN

Practical foundrymen were particularly interested in Mr. A. Marshall's Paper on "The Production of Some Engineering Castings" when it was presented in Manchester to the Lancashire Branch of the Institute of British Foundrymen. A report of the discussion is given below. The Paper itself appeared in our last two issues.

Running Lathe Beds

MR. A. SUTCLIFFE, SEN., asked why, if the author formed the gap in the lathe bed (Fig. 4) by means of a dry-sand core, he did not cut a runner on each side of it, as it would prevent the metal having to jump the core? The metal would then fill up the main runners simultaneously and be much livelier. He had personally frequently so made 8-ton lathe bed castings, 32 ft. long.

An example had been shown of running into one basin down two runners, along some more channels, up two other runners and finally down the main runner. Because of the liability to lose heat, he questioned whether the method would be generally satisfactory.

He asked how the lecturer ascertained the dividing line between a green-sand and a dry-sand job; the position as to loam work was better defined.

In gating a lathe bed at the ends, did the lecturer consider it necessary to put risers on all of them? Cases were known where no risers were used, though personally he preferred to have one. Had Mr. Marshall ever made the feet cast integrally with the body of a lathe bed, say, from 1 ft. to 2 ft. depth? He recalled an instance where an attempt was made to do this, and the initial result was a waster, due to faulty design. After detailing the moulding procedure, which was perhaps more suited for the making of sizes somewhat smaller than the lathe bed dealt with by the lecturer, Mr. Sutcliffe then described the making of gun turning lathes, which involved the turning over of the top part containing the "sugar loaf" but not the side cores. He recently inspected a lathe which he had made 25 years ago. It was still working satisfactorily, but the plate was somewhat soft and needed replacement. It should be remembered that when bolting up to the base-plate there might be sand on the teeth, which would bore in with vibration and show a mark.

Mr. Marshall had referred to a lathe casting showing froth on the upper surface. He had put a riser there, but no dirt would come up a riser, yet a certain amount of scum must have been developed in the mould, and the top bosses would be liable to show up that dirt on machining.

Trap Runner Described

MR. MARSHALL, referring to Mr. Sutcliffe's criticism, said he understood him to advocate gating up at the side of the slide of the lathe bed mould. His experience in this connection was that there was a tendency to have particles of dirt at the juncture of the gate and the casting. The slide was cut to a V shape on the pattern, probably about $\frac{1}{8}$ in. at the edge. He did not mention that the trap runner was used in the particular lathe bed referred to by Mr. Sutcliffe. Gating took place along the slide face, two in-gates connected to separate down-gates together with two small gates cut at the opposite end of the mould was the method applied in this type of bed.

Limit of Green-Sand Work

The point regarding green sand and dry sand certainly presented a problem. To decide when a job should be made in green sand or dry sand, one had to take into consideration the design of the casting to be produced. The firm with which he was associated did fairly large jobs of the type indicated in green sand; actually the maximum weight would be 2 tons 15 cwts. He had never had to deal with such large feet on a lathe bed as had been mentioned by Mr. Sutcliffe. Happily, however, at the Paisley works co-operation between the design office and the foundry was of a very cordial nature. When he could make out a reasonable case that a casting would be considerably reduced in cost, without interfering with the performance of the unit, there was no hesitation about following his advice.

He agreed that dirt would only come up a riser if it were directly underneath it; any scum that came up had a chance of passing into the cut risers, which were more in the nature of a heavy "fin" connected to the edge of the stool faces.

MR. J. MASTERTON recalled that the lecturer had mentioned that the majority of the castings were in green sand. Would he give some particulars of the sand with regard to permeability, bonding, etc.?

MR. MARSHALL said the green-sand strength per sq. in. was about 4.7 and the permeability might go as high as 101. Regarding the "whistlers," this was a "cleaner" hole taken off at about half a dozen points round the top joint of the mould. In casting the pulleys there might be seen coming out of the top joint a splash of metal, but no more; this was due to the metal being very hot and running to the outer edge of the "whistlers" which were about $\frac{1}{16}$ in. diameter.

Patterns and Design

MR. W. HOWE, referring to patterns, asked how many types of lathes Mr. Marshall usually made. Was there one basic design or several?

MR. MARSHALL replied that there were several.

MR. HOWE suggested the pattern should be a box to carry block cores so that labour costs would be saved. Reference had been made to a plate or frame, and the cutting out of certain work in order to get four members in one. Nowadays, the idea, he thought, was to make something which would exert a sales appeal. Many machines produced at the present time were practically the same as were produced 50 years ago, with the addition perhaps of a few ball-bearings, etc. The desire seemed to be for something which looked massive when cast in one piece, although it was not really so. He thought most lathes now had the feet cast separately so that a tray could be put in.

MR. MARSHALL assumed that Mr. Howe was dealing with the first bed pattern, and he had mentioned in the Paper that the pattern construction left room for improvement. He agreed with Mr. Howe on that point, but it was a type of machine which was constantly varied.

MR. HOWE suggested the design might be altered.

MR. MARSHALL said that that would involve pattern cost, with a reduction in length; this would involve alteration of the core boxes. There was also reduction in length and angle of supporting ties. Actually the bed pattern with the gap was entirely cored out, because the top of the wood-working lathe was more or less standard and was worked right through the piece. Mr. Marshall asked if the projecting slides referred to by Mr. Howe were worked loose.

Blocked Core Production

MR. HOWE said they were not drawn in at all. They were simply put in a box, and a core was inserted. By this means he received one per day, weighing 9 or 10 cwts., and measuring 6 ft. 6 in. in length.

MR. MARSHALL said that actually his firm was getting one a day too, but he was a little doubtful about the time, since Mr. Howe's suggestion involved extra core making. However, it was a point worth consideration.

MR. HOWE said there was not the same chance of drawing in loose pieces of sand from the dry cores.

MR. MARSHALL then spoke of the planer frame, saying he could not agree that the idea was to make it appear massive.

Wooden Lifting Beams

MR. H. HAYNES asked whether the lecturer preferred turning over or bedding in the jobs; apparently the latter was preferable in order to ensure the success of the castings. With large castings, did the lecturer dry the runner basin in order to get clean castings? With regard to the machine frame which the lecturer termed casting in one, it seemed to him to be a haphazard way of assembly. He believed in safety-first in the foundry. When lowering the top box over the core there appeared to be about 3-in. pieces of wood to form a beam. He did not think it necessary to use wood when it was possible to have a steel beam.

Mr. Haynes agreed with the remarks which had been made about patternmaking with regard to blocking out the castings. He himself had noted the same points for discussion.

MR. MARSHALL said that actually the pieces of wood were 3-in. skids of pitch pine, with steel pins passing through the chain links, and, in his opinion, they were thoroughly safe.

MR. A. SUTCLIFFE, SEN., asked whether their use was essential.

MR. MARSHALL insisted that it was so, otherwise there was a likelihood of fouling the box when at an angle. With wood to metal there was a better grip; with metal to metal there was a liability to slip.

MR. HAYNES thought it would pay to make a modern box and to have a steel beam carrying notches to suit all kinds of boxes, instead of hard wood.

MR. MARSHALL said that by using this method he had made 75 castings, and had not lost one.

Cost of Blocking-Out Methods

MR. E. LONGDEN was of opinion that Mr. Marshall's methods of making castings were quite sound. One could argue for a long time as to the correct kind of tackle to use. Wooden beams were used in many foundries, because of the existence of a large miscellaneous lot of boxes with which notched beams could not be used.

Referring to the box-shaped casting which had been mentioned, he wondered if Mr. Marshall had considered the advisability of making hinged moulding boxes for it, and building up the core into position in the mould. Considerable expense, of course, would be involved in the making of the boxes, but if sufficient castings were required, the system could be recommended.

The reference, by one of the speakers, to blocking out by cores was a very questionable practice if one was a foundry manager, and had to look to ultimate cost. One might make the casting in a day, but it must not be forgotten the coremaker was working at the same time. Core irons had to be made, material had to be dried, there would be handling about the foundry, etc. He had heard the story too many times about saving cost by blocking out patterns, but it was necessary not to overlook ancillary costs, such as for the making of cores, drying operations, transport, etc. These items were not always debited to the particular job.

Weight Reduction

MR. HOWE said that the way he made a pattern there was a reduction of 3 cwts. odd in the casting.

MR. MARSHALL said he was tied down to very fine limits, and if he got over 5 per cent. he would get the casting back.

MR. HOWE said that if they had to draw in the slides, it increased the weight of the castings by 3 cwts.

MR. MARSHALL thought it was bad moulding if one got 3 cwts. above the estimated weight in a casting weighing 10 cwts. Referring to Mr. Longden's remarks, he had considered the provision of hinged boxes, but the job had to go into production and it was a new design. He was a little doubtful about using a hinged box in a job of this depth. The suggestion was worth consideration and he would keep it in mind.

MR. J. JACKSON thought it could now be realised that there were many different but equally good ways of doing a particular job. As had been remarked in the lecture, the chief thing, whichever way it was done, was to make a satisfactory casting. From the experience he had had of the machinery made by Mr. Marshall's firm he could certainly say a good job was turned out. The machines he had in mind performed the work so rapidly that the great consideration was how to remove its production promptly to make room for more.

MR. E. LONGDEN remarked that there were hundreds of lathe bedplates being made to-day with feet cast integrally just as formerly.

Machining Qualities

MR. MARSHALL, in replying to Mr. A. Sutcliffe, Senr., said he had received no complaint from the machine shop as to the properties of the pulleys and the loss of the edge of the tools used. His firm used tools with fairly hard tips. The edges of the pulleys were machined.

MR. J. POTTER, speaking with regard to the bore in the cylinder, asked whether they were bored out, or whether a liner was inserted.

MR. MARSHALL replied that no liners were used. In further reply to Mr. Potter, the lecturer stated that a certain amount of trouble due to porosity had been experienced in the first three castings; but with the introduction of chills this trouble had been completely eliminated.

MR. POTTER said he had had some experience with Diesel engines in which a liner system had been adopted for both large and small engines.

Multi-Membered Castings

MR. E. SUTCLIFFE, JUN., referred to the design of castings in one piece. There were definite reasons why castings of special machine tools were not designed in one piece, and one was on account of machining. The casting shown by Mr. Marshall was of a wood-working machine all in one piece. There could not have been very much machining in the centre. If any planing was required in the centre of the casting it was necessary to make the brace piece over the top a separate casting, and also the side uprights. A cross or brace piece made a rigid job both for machine tools and wood-working machinery, but there were cases when if machining was necessary in the centre of a casting in one piece it was difficult to perform.

Another point when designing a machine tool or wood-working machinery was to make a cap bearing with phosphor bronze. By this means one could drop the assembled shafts and gearing in from the top. Otherwise it would be necessary to thread the shaft through a hole which was bigger than the shaft, and also thread the gears on to the shaft inside the gearbox of the machine.

Speaking of the methods of making lathe beds referred to by Mr. Sutcliffe, sen., and by Mr. Longden, he thought they both made them correctly, although there was a certain amount of difference between the two designs. The box section was the better design for rigidity of heavy and medium machine tools. The other design was for a lathe or machine tool with a long straight bed with feet in different positions. This might make it very awkward to cast them in one piece; but he thought, with feet on, the shears were best cast by themselves and the feet the same. Mr. Longden's design, being a box section, was much easier to cast integrally.

MR. MARSHALL replied that in regard to the five castings in one the machine shop was satisfied, taking into consideration the cost they had to pay for the casting, plus the reduction in machining time, that it was the cheapest job and the best.

Chills and Porosity Elimination

MR. J. R. PLATT, referring to the illustration of a marine cylinder, noticed that chills were used for the purpose of eliminating porosity in certain of the sections. Last year, he had mentioned a similar point with regard to some deep castings made with brackets or feet on the bottom. He then stated that he had eliminated porosity in the feet by inserting chills. It had then been suggested by a speaker that, by taking the porosity out of the feet, it was transferred to some other portion of the casting. How did Mr. Marshall view this attitude?

MR. MARSHALL thought the ideal method of chilling would be to move the porosity into a riser and for fresh metal to be fed at that point. He thought this was really the object in the use of chills.

MR. LONGDEN said the statement must not be imputed to him that if a casting was chilled there was a removal of the porosity to some other point in the casting. He had been combating that view for a number of years. Porosity and cavity could be eliminated in any class of metal if chills or denseners were applied suitable to the class of metal and a progressive order of solidification.

He wished that there were only box-shaped bedplates to make; his firm had probably orders for machines in the region of 100 with bedplates and feet cast integrally. It was also necessary to consider the question of rigidity, which was much greater in a completely single body than a composite one.

MR. POTTER said that everyone used chills at some time or other. Mention had been made by the lecturer that he kept the chills "very clean"; what was meant by that phrase? Were the chills coated, and, if so, with what?

MR. MARSHALL said that the face of the chill was actually ground to free it from rust, sand, etc., and it was painted with a little plumbago and oil.

MR. POTTER said he used to paint chills with plumbago and oil, but when the moulds were dried in the stove, the chills were rubbed with sandpaper and painted with aluminium paint after drying operations.

MR. MARSHALL said the chills were not used too often.

Venting

MR. J. LAING raised a point with regard to venting. The lecturer had stated that in one instance illustrated in the Paper the practice was to vent in green-sand moulds down the side of the pattern down to the bed. He thought this was wrong. If there was venting down to the cinder bed, the moment the metal ran across the bottom of the mould the side vents were filled by air pressure. If these were disconnected from the bed, there was no pressure in the side vents until the metal rose up the side walls. Why did Mr. Marshall connect them to the cinder bed?

Mr. Marshall had also remarked that the pouring temperature in the case of the cylinder was very important. He did not indicate whether the minimum or the maximum pouring temperature was meant. He (the speaker) did not suggest that 1,280 deg. C. was the maximum temperature at which casting could take place on the particular job; but had Mr. Marshall intended that?

It had been said also that it was difficult to estimate a cost if much hand labour was required. He assumed Mr. Marshall intended to convey it was difficult to estimate for a price.

MR. MARSHALL said it would be understood that the green-sand cores were vented seperately. That method had been proved to be quite satisfactory, and no trouble whatever was experienced with it. The gases came off very freely, and during the past five years he could not recall losing any casting made on that principle. With regard to the cylinder, 1,280 deg. was the minimum pouring temperature.

Estimating for Jobbing Work

Regarding estimates, he had tried to convey that, in a considerable number of jobbing shops, a job which might be for 60-off might drift through for some time before it was discovered that it was actually being made at a loss. If there was a system of costing which could be checked at any time during the day by the marking off of a card, the possibility of loss being incurred could be eliminated.

MR. LONGDEN asked what was Mr. Marshall's method of estimating temperature, because 1,280 deg. was rather low.

MR. MARSHALL replied a pyrometer was used. The normal temperature was from 1,280 deg. C., minimum, up to about 1,360 deg. C., maximum.

Director for Iron Castings

APPOINTMENT OF MR. FITZHERBERT WRIGHT

Mr. FitzHerbert Wright, who has been appointed Director for Iron Castings (Iron and Steel Control—Ministry of Supply), is a director of the Butterley Company, Limited, of Derby, a concern which celebrated quite recently its 150th anniversary. It is interesting to note that the family of the new Director has been associated with the direction of the Butterley firm for the whole of this period. Mr. Fitz-Herbert Wright was educated at Eton and Sandhurst. His works experience began with Butterley, where he worked in the collieries and works. Later, he was connected with Ransomes & Rapier, Limited, of Ipswich, being works manager there for a few years, and eventually returning to Butterley with a seat on the board. The Butterley Company has invariably interested itself in iron, and, in recent times, has embarked upon an extensive scheme of mechanisation and has additionally acquired a licence for the manufacture of Meehanite metal.

MR. FITZHERBERT WRIGHT.

Some Principles of the Enamelling of Cast Iron

By G. T. O. MARTIN, Ph.D.

(*Concluded from page* 264.)

Relative Coefficiencies of Expansion

In dry-process enamelling particularly, considerable attention is given to the coefficient of thermal expansion of the enamel and of the iron. The enamel should normally be in a state of slight compression when cold, as it will withstand some compression, but cannot resist much tension, which causes the formation of the fine cracks known as crazing. Dry-process enamel has less latitude than wet-process enamel in this respect, since it is a comparatively thick homogeneous layer of glass, while a wet-process enamel layer contains many small gas bubbles, which help to absorb and break up stresses and, particularly with directly applied enamel, is much thinner than a coating of dry-process enamel.

To ensure a final state of compression, the contraction of the enamel after solidifying must be less than that of the metal from that temperature. The enamel should therefore have an expansion coefficient somewhat smaller than that of the metal in this temperature range. Just how much smaller will depend on the type of enamel, the shape of the casting on which it is applied, and the conditions under which the enamelled casting is cooled. In wet-process enamelling the greater latitude generally takes care of these factors to a large extent, and wet-process enamels of different types are successfully applied to castings of various shapes made in iron of quite a wide range of analysis, without trouble from chipping or crazing. With dry-process enamels it is necessary to maintain more closely the correct relation between the thermal expansion coefficients of iron and enamel.

The thermal expansion coefficients of enamel and cast iron can conveniently be considered together. The recent Paper by Black on "The Control of Enamels"[9] describes the measurement of such expansion coefficients and the interpretation and use of the results. It certainly shows that the only reliable means of obtaining these values is by actual measurement. Calculation of the expansion coefficient of cast iron from its chemical composition is practically impossible with present knowledge, as the results for a number of cast irons tested bear no systematic relation to their compositions. An additional complicating factor is the effect of the structure on the expansion coefficient. It was found that an annealed sample, with low combined carbon content, has a greater expansion coefficient than an unannealed sample of the same iron. On again heating to 900 deg. C. there was a second increase in expansion coefficient, but a third heating gave no further increase. These changes are presumably related to the breakdown of combined carbon.

Calculation of Expansion Coefficients

Calculation has been widely used to obtain the expansion coefficients of vitreous enamels. The pioneer work of Winkelmann and Schott[7] on the thermal expansion of glasses was extended to enamels by Mayer and Havas,[10] who measured the expansion of enamels of different compositions from 0 to 100 deg. C. and calculated factors for the various oxide components. The factors used to-day are based essentially on these results. Andrews and Smith[11] found that the factors gave reasonably accurate results for temperatures up to the softening point, but special allowance had to be made for fluorides present in cover-coat enamels. The general opinion about such calculation from factors seems to be that it is not capable of giving strictly accurate results, but when used for enamels of similar composition, or small variations of a given composition, prepared and used under the same conditions, the results are comparable and can be used to estimate the effect of small changes of composition on the thermal expansion coefficient.

The calculation is based on the melted composition of the enamel, which is generally calculated from the raw batch, allowing for changes and losses during smelting, and rarely from a chemical analysis of the frit. Although it is a comparatively simple matter to calculate the amounts of the various oxides introduced by the raw materials, by allowing for the loss of water, carbon dioxide, etc., it is not possible to allow exactly for the amounts of boric oxide, sodium oxide and potassium oxide that were shown by Poste and Rice[12] to be progressively lost during smelting. This can appreciably affect the expansion coefficient and other properties of the enamel to the determination of which calculation has been applied.

In the melting of glass in continuous melting tanks, measurement of the thermal expansion coefficient is used as a control of melting conditions. This would, of course, be equally applicable to enamels, if they were melted continuously, as is done in large-scale manufacture in the United States, but for batch melting such a method is impossible, on account of the time taken for the measurement. It would certainly be more exact than the methods in use at present, which depend to a large extent on human judgment.

Batch smelting is sometimes conducted on a time and temperature basis, but temperature measurement is at present the exception rather than the rule. Methods of estimating the correct stage of smelting include visual observation of the appearance of the melt, and the drawing of a thread of enamel glass and examination of this for elasticity by bending in a loop and for undissolved particles by running between the fingers. A refinement of the latter method is examination under the microscope, whereby some idea of the nature of the undissolved particles can be obtained.

Incidence of Stress

The relation between the expansion coefficients of cast iron and dry-process enamel will usually depend on the type of article being enamelled. Thus for smaller articles, usually enamelled by dry-dipping, the difference in the two coefficients can usually be smaller than for larger objects such as baths, since the smaller surfaces of such castings will not give rise to such large stresses. The direction and sharpness of any curves will also be important.

On concave surfaces the compression stresses in the enamel act in support of the adherence force, but on convex surfaces they act in opposition to the adherence, and given a sharp enough curve or a sufficiently large difference in the expansion coefficients, the adherence force may be neutralised or exceeded, causing chipping off of the enamel. Thus it is sometimes necessary to use an enamel with a somewhat higher expansion coefficient on such convex surfaces, for example, the rolls and roll edges of baths. Fig. 5 shows the forces acting on enamel applied on convex and concave surfaces. The cooling conditions will play a part in determining the stresses remaining in an enamel layer when cold, but this is considered later.

Interfacial Conditions

The adherence of enamel to cast iron is probably largely a mechanical process for wet-process enamel when a ground coat is used. In the case of dry-process enamels, chipping off the enamel reveals a dark layer between metal and enamel, which is probably produced from the thin ground-coat layer by absorption of iron oxide during fusing. This layer prevents reduction by the iron of oxides in the cover enamel, and forms a bonding layer between the iron and the enamel, and if the ground coat is overfired faulty adherence results. The so-called "burned" ground coat has lost most of its vitreous nature and greatly changed its expansion coefficient due to saturation with iron oxide. A similar dark layer, though less pronounced, is usually found under directly applied wet-process enamel. In sheet steel enamelling the solution of iron oxide by the ground or grip coat is an essential reaction, as it raises the coefficient of thermal expansion of the lower layer to that of the metal.

Much has been written about the expansion of dry-process enamels for cast iron, but the ground coat is rarely mentioned, and it is to be presumed that there is more latitude in its composition and properties than those of the cover enamel, perhaps because only a very thin layer is applied. That the black layer is thinner under direct wet-process enamel is probably due to the lesser capacity for dissolving iron oxide, and also to the fact that the thicker coating protects the metal more before fusing of the enamel, and prevents oxygen diffusion through the enamel after fusion has occurred. Underneath a correctly fired matt ground coat there is a black layer of oxide, but this does not seem to have reacted with the enamel, since it is not vitreous in appearance and can be easily removed from the metal.

Considerable evidence has been produced to show that at the interface of sheet steel and grip coat there is a very thin layer of ferrous oxide forming the connection between the metal and the lowest layer of enamel, which has dissolved sufficient iron oxide to increase its expansion coefficient to that of the metal. Cast-iron enamels undoubtedly dissolve some iron oxide, as shown by the darkening of the lower layer in contact with the metal, but the gripping action produced by the rough blasted surface is probably responsible for more of the adherence than any ferrous oxide film similar to that produced on the comparatively smooth sheet steel surface. This is supported by the fact that

blasting is the most important factor in producing good adherence of enamel to cast iron, quite apart from its thorough cleaning of the surface, which also helps to prevent gas bubble defects.

THE ENAMELLING PROCESS

Reasons for Annealing

Beginning with the preparation of the castings for enamelling, the question of whether annealing is advisable arises first. This has been discussed in the first section, where the effect of annealing in driving out entrapped gases and breaking down combined carbon is described. Annealing also burns off any carbonaceous facing material, softens the casting surface, thus rendering blast-cleaning easier and loosening any burned-in sand, and burns out the graphite flakes at the surface. Moreover, if the casting has been allowed to become rusty, any bad influence this might have on the enamelling is removed, since the rust which causes most of the trouble is that in the cavities around the graphite flakes, and this is removed by reaction with the graphite.

It is usually found that for best results, enamelling must be completed as soon as possible after annealing. This is probably because the iron in the graphite cavities is now in a very reactive state, and readily re-oxidises, causing further gas evolution when the enamel is fused. Annealing also removes any stresses remaining in the raw casting after it has cooled, and thus helps to prevent warping in the subsequent enamel fusing. Annealing is a question of time as well as of temperature, and it is generally found advisable to keep a furnace specially for the purpose. Such a furnace need not be of the muffle type, as the furnace atmosphere is not so important as in the enamel fusing. The best method of annealing castings is not to run a light load (resembling a normal fusing load) into the furnace, bring it up to the annealing temperature and then withdraw it. The castings should be allowed to "soak" for a time at the annealing temperature, making sure that even the thickest parts reach the temperature of the furnace and remain there for a time. The increased time in the furnace naturally slows down the output and to compensate for this heavy loads are used to ensure economy of operation. In direct wet-process enamelling with acid-resisting enamels, the charge of castings may be in the annealing furnace for as long as one hour, for about 20 minutes of which they are at the maximum temperature of 800 to 820 deg. C.

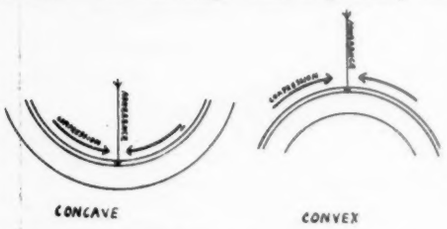


FIG. 5.—DIAGRAMMATIC REPRESENTATION OF STRESSES IN ENAMELS UPON CURVED SURFACES.

The processing is then completed as quickly as possible, a time limit of 12 hours being specified in some cases. With more workable enamels the conditions are less rigid, but it is advisable to complete processing as soon as possible after annealing.

Why Cleaning is Essential

Whether or not annealing is practised, the surface of the casting must be thoroughly cleaned, and this is generally done by means of a stream of abrasive, projected by an air-blast or by centrifugal force. In a few cases castings for dry-process enamelling are cleaned by scouring with a stone and water. This does not roughen the surface nor remove facing compounds such as plumbago or quartz, and it is thus much more difficult to obtain good adherence of the enamel to the iron. Stresses arising from differences in the expansion coefficients of iron and enamel and from the design of the article must be smaller, this involving more rigid control of the properties of the iron and the enamel.

The use of sand for blasting has been almost completely abandoned and chilled iron is used. It is often stated, however, that sand has a more gentle and uniform cleaning action than shot and leaves a more finely grained surface. The disadvantages are, of course, the health hazards and regulations, and the restriction of its use to all-enclosed types of equipment.

In a sand-blast room, as used particularly for larger castings, the casting is stationary and the nozzle from which the abrasive issues is moved about by hand, so that the whole of the surface can be thoroughly cleaned by an experienced worker. In airless blasting, however, the direction and extent of the abrasive stream are fixed and the castings must be moved in the path of the abrasive in such a way that all parts are cleaned. In the case of small castings, this is best accomplished by tumbling them in a barrel in the path of the abrasive. In another type of plant, the castings are carried across the stream of abrasive on a rotary table, while in a third type, a straight-through conveyor is used. In these cases the edges of flat castings usually receive less cleaning that the faces and it is often necessary to go over them separately with a nozzle. Edges, corners and depressed parts are the places most likely to give trouble from bubble defects due to insufficient cleaning.

Filling Materials

In most cases blasting will expose a few holes in the casting surface, and to obtain a smooth coat of enamel, these must be suitably filled before enamel is applied. For this purpose a refractory composition resembling a ground coat or a purified fireclay is employed, although a mixture of iron filings and sodium silicate is successfully used in some cases. These filling compounds should contain as little water as possible, so that the filling dries out quickly and without shrinking when the first enamel coat is dried before fusing, since any water remaining will come off during fusing and cause blowing out of the filling and lifting of the enamel. The holes must be completely filled.

The casting is now coated with enamel and the first coat is invariably a wet-process one. The cleaned and roughened surface of the metal rusts very readily and castings to be enamelled by the wet process are dried as rapidly as possible to minimise rusting. For this purpose, also, salts are sometimes added to the enamel slip to prevent rusting, such as borax or sodium nitrite. This rusting does not appear to be important in dry-process enamelling, where the very thin ground-coat application is simply allowed to dry in the warm shop, and the rust can plainly be seen under the dried coating.

When wet-process enamel is applied directly to the iron as a single coat, any rusting may spoil the final appearance, as dark marks may show through the final enamel, especially if it is light in colour. These are due to solution of the iron oxide by the enamel and the effect, in a controlled form, is used in the production of a mottle finish on hollow-ware in the United States. Rusting of the iron during the drying of matt ground-coat enamel may cause faulty adherence, as this enamel has not the same capability of dissolving iron oxide as a completely melted enamel has.

Spraying is used for the application of wet-process enamels to cast iron, but ground coat for dry process is applied by dipping, pouring or brushing or a combination of these, spraying being sometimes used for touching-up awkward places. This enamel coat must be very thin and the slip has a greater water content than a wet-process enamel slip. Wet-process enamel slips have the greater "set," that is, a greater force is required to start them flowing. An enamel slip is a mixture of frit grains, opacifiers, colour oxides, etc., with clay and water, and behaves not as a liquid, but as a plastic solid. This property is due to the clay, which is present to about 6 per cent. of the frit weight, or between 4 and 5 per cent. of the total weight. The fine clay particles are electrically charged by the electrolytes present in the slip, which may come partly from solution of the frit during milling, and partly from salts added to the slip or the mill charge.

The application of pressure to plastic materials produces no flow until a certain force is reached, known as the "yield value." Above this pressure, increase of force causes increased rate of flow, and the rate of increase of flow with increase of pressure is called the "mobility." In Fig. 6, OA represents the yield value and the slope of the line AB, that is, $\frac{BC}{AC}$ represents the mobility. If an object, say a casting or piece of sheet steel, is dipped into an enamel slip and allowed to drain, the speed of draining is governed by the mobility, and the thickness of enamel slip remaining on the object is decided by the yield value. The enamel is said to be "short" when the yield value is too great.

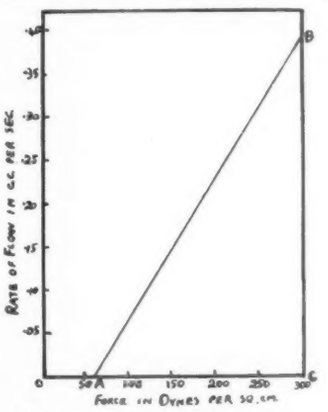


FIG. 6.—FLOW OF ENAMEL SLIP.

For spraying enamels the mobility decides the rate of flow through the gun at a given air pressure, while the yield value must be sufficient to prevent flowing of the enamel on the surface of the ware during or after spraying. In many cases the milling process causes sufficient electrolyte to be dissolved from the frit to cause the clay to divide into small charged particles. In some cases, particularly with resistant types of enamels, it is necessary to add electrolytes in suitable amount, generally a few tenths of a per cent. of the frit weight.

The drying of wet-process enamel on cast iron should be as rapid as possible to prevent contamination by dirt in the atmosphere and avoid rusting, and heat is necessary to ensure this. Water is removed from the enamel coat by evaporation at the surface, and water from the interior diffuses through the layer to the surface to replace that lost. If the evaporation takes place faster than the diffusion, the surface becomes dried first and the enamel will crack, leaving markings which will remain after fusing. This effect is known as tearing. To avoid this type of defect, the casting and enamel must be hot before any considerable evaporation takes place, and this is done by heating up in a humid atmosphere, usually in a special dryer, and then gradually reducing the humidity as the evaporation proceeds. Drying at lower temperatures, say up to 100 deg. F., is much slower, but less critical, and tearing is not likely to occur. When the enamel coat is dry, the clay gives strength

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Stanton-Dale is a pig iron of low total carbon, the graphitic carbon being uniformly distributed and of fine curly-flake formation. The close structure ensures remarkably high strength with good machineability, and Tensiles of 16 to 20 tons can readily be obtained when a proportion of Stanton-Dale Iron is introduced.

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Total Carbon from 2.6 per cent. upwards. *Analysis to individual specification as required.*

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to the biscuit, and prevents damage in handling or operations such as brushing.

Degree of Grinding

In addition to the consistency of the enamel slip, the degree of fineness to which the frit particles are ground is an important factor. This is usually expressed as the number of grams in a given volume of slip, say 100 c.c., remaining on a given mesh sieve, 150 to 200, and this property is checked before the slip is discharged from the mill. The degree of fineness to which the enamel is milled is a matter of compromise. Fine grinding increases opacity and gloss, and helps to produce a smooth surface, but may cause "tearing" during drying or "crawling" (a similar effect) during heating up in the fusing furnace. Moreover, it may lead to excessive solution of the frit, causing difficulty in adjusting the set. Coarse grinding on the other hand may not give the maximum benefit of the opacifier added, renders a smooth glossy surface more difficult to obtain, and may cause settling of the slip or standing, but allows of greater latitude in drying conditions. Each plant must determine the degree of grinding best suited to its particular working conditions and maintain it by control tests.

The grinding of dry-process enamel is a simpler operation since fewer factors are involved. Frequently no additions are made to the mill, and the powder is usually merely ground to pass a certain mesh sieve. Here again a compromise is necessary, the degree of fineness depending on working conditions. Finely ground powder makes it easier to obtain a smooth even coat by dusting, and avoids any sliding down surfaces such as bath sides, but may cause considerable waste by the finer portions being blown away. In dry dipping, however, these factors do not apply, and coarsely ground enamel is generally used.

Factors in Fusing

The conditions under which the enamel is fused on to the castings can greatly influence the quality of the final product. Every enamel has a certain "fusing range," and the temperature reached in the furnace should be within this range. Finer grinding makes wet-process enamel fuse more readily, and *vice versa*, but in practice this is not found to be a factor of any considerable importance. The thickness of the castings and the weight of the charge in a batch or box-type furnace will decide the time necessary for the enamel to be correctly fused.

Variations in thickness in the castings cause the enamel on different parts to fuse at different rates, and reduce the margin between under- and over-firing. In extreme cases, it may be necessary to withdraw the load for a time to allow the thinner parts to cool off, so that the second heating brings all parts up to the fusing temperature at the same time. In dry-process enamelling this difficulty does not arise to such an extent, but uniform thickness is nevertheless advisable, to ensure uniform application and freedom from stresses.

In the fusing of wet-process enamel on cast iron, a considerable amount of gas is always evolved from the metal, and must pass through the enamel. Gas passing through the biscuit before melting takes place will cause no trouble, but if gas is still being evolved when fusion is complete, gas bubble defects will occur. Many plants prefer to run a heavy load into the furnace, and bring it up to fusing temperature slowly, so that gas evolution is as complete as possible before the enamel fuses. Since gas is always evolved while the enamel layer is fusing, underfired enamel is characterised by the large blisters all over the surface, and poor gloss, with sometimes a filmy or greasy appearance. With correct fusing these blisters burst and heal over, leaving a smooth surface.

Continued fusing may cause a reduction of gloss or a pitted surface, particularly if the temperature is at the top of the fusing range. The thickness of the enamel layer applied will be a factor in deciding the fusing time required. A thick layer will require a longer time than a thin one, and will show a greater tendency towards gas bubble defects, as the gas cannot escape so readily as through a thin layer. Successive coats of enamel are fused at decreasing temperatures, even when they are of the same enamel.

In the case of dry-process enamels, most of the gas is evolved during the fusing of the ground coat, and any gas evolved during the dusting or cover coat fusing can pass through the enamel since the latter is maintained in a fluid state for a much longer period than in wet-process enamelling. For this reason it is generally agreed that castings for dry-process enamelling need not be so free from defects as those for wet-process enamelling, although all castings for enamelling should be as free as possible from defects of any kind.

Furnace Atmosphere

Vitreous enamel must be fused on to the metal in an atmosphere resembling as closely as possible ordinary air, and with fuel-fired furnaces this involves the use of a muffle. It is difficult to prevent small quantities of the furnace gases from penetrating through the muffle in the fusing chamber, and enamel defects may arise if appreciable amounts of sulphur dioxide, carbon dioxide and water vapour can enter the muffle atmosphere in this way. Some grades of fuel oil cause difficulties in this connection, due to sulphur content. It is generally considered that fuel oil containing more than 0.5 per cent. sulphur should not be used for enamelling furnaces. Sulphur dioxide in the furnace atmosphere reacts with the alkali oxides in the enamel to form sulphates. This may sometimes cause a scum or film to be left on the enamel surface, but the usual effect is the production of a white deposit on standing, due to absorption of moisture. This deposit can be washed off and proved to be sulphate by analysis. Some enamels are more sensitive than others to the effect of sulphur dioxide.

The effects produced by carbon dioxide and water vapour are less marked and little has been written about them in this country. Carbon dioxide can cause poor gloss, and water vapour poor gloss and blistering defects. The fusing of wet-process enamel drives off combined water from the clay so there is always some water vapour in the atmosphere of such furnaces, but trouble arises if a certain limit is exceeded.

Cooling Conditions

The conditions under which enamelled castings are cooled after fusing should in theory be very important, but in practice it is found that there is considerable latitude. In referring to the difference in expansion coefficients of iron and enamel leading to a final state of compression of the enamel when cold, it was assumed that the iron and the enamel cooled at the same rate, but this is rarely true in practice, except perhaps in continuous furnaces. If the enamel is on the outside of the casting, it will cool more rapidly than the iron. Moreover, since enamel is a poor conductor of heat, the outer surface of the enamel will cool more rapidly than the inner layers, and in thick layers this can produce internal stresses in the enamel layer itself, which may lead to delayed failure of the enamel by crazing or chipping, or result in poor resistance to impact.

The difference in the rates of cooling of the iron and the enamel in contact with it leads to a temperature difference between them when the enamel becomes solid, which will modify the compression effect produced on the enamel by the difference in expansion coefficients. If an object enamelled on the outside is cooled rapidly, the difference in expansion coefficients can be smaller than when it is cooled slowly. If a casting is enamelled on the inside, the enamel may cool more slowly than the iron, and the difference in expansion coefficient should be greater. These considerations apply principally to dry-process enamelling, and explain why some plants find it necessary to cool the fused ware slowly, while others take no special precautions.

In conclusion, it must be admitted that a number of important aspects of the enamelling process have not been mentioned, but enamelling involves so many different operations that reference to all of them would be very difficult. The points discussed are those in which most interest has been expressed and about which controversy and misunderstanding have arisen.

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[10] "Sprechsaal," 1909, vol. 42, p. 497; 1911, vol. 44, pp. 188, 207, 220.
[11] Journal of the American Ceramic Society, 1933, vol. 16, pp. 328–337.
[12] Journal of the American Ceramic Society, 1918, vol. 1, p. 221

DISCUSSION

MR. T. TYRIE, in opening the discussion, asked whether Dr. Martin had any experience of the effect of excess manganese beyond that required to balance the sulphur. Blistering troubles had arisen when enamelling castings made from an iron containing 0.8 to 1.0 per cent. of manganese; yet the same castings poured with an iron similarly constituted, except that the manganese was only about 0.4 per cent., gave no trouble whatever. This naturally led to the supposition that the blistering might be attributed to the stabilising action of the excess manganese on the carbide, rendering the normal shop annealing practice less effective, with the result that carbide breakdown continued during the subsequent enamelling operations with the evolution of gases and the production of blistering troubles. Mr. Tyrie also said he had had his attention drawn to the appearance of a white scum on an enamel surface some time after the goods had been processed, and he had read that sulphur vapour in the muffle atmosphere might produce that. It was interesting to learn that Dr. Martin had examined such a scum and had been able to confirm the presence of sulphate.

DR. MARTIN replied that the trouble usually experienced was to induce people to use sufficient manganese, as he had never found anybody using an excess if everything else was satisfactory. He had seen statements in the American Press recommending 0.7 or 0.8 per cent. manganese, but, like many other things found satisfactory in that country, this practice could not be applied here. With regard to the white scum, its occurrence might be due to the fuel oil used or a leakage into the furnace. Fuel oil was now pooled, and colour was affected, resulting in a kind of dullness. He had seen it stated that scum consisted of alkali sulphates.

A Standardised Composition

MR. R. R. SHAW said that, not being an enameller, he could not offer any criticism on that aspect of the matter. Dr. Martin's reference to the enamel being in a state of compression in preference to a state of tension was very interesting from the point of view of the jobbing enameller. The jobbing enameller frequently complained when receiving castings from different firms. He found that the enamel which would suit one make of casting was useless for another. Mr. Shaw thought it would be of use if the district foundry managers could agree upon and work to a standard analysis of iron containing 2.8 per cent. silicon and 1 per cent. phosphorus maximum. This would eliminate a great deal of trouble for jobbing enamellers.

MR. JOHN DONALDSON, who presided, said that one trouble all wet-process enamellers experienced was blistering when refiring a "direct-on" enamel. He wondered if anything was

FRY'S Solder Reference Tables

TINMANS SOLDERS

Grade B.S.S.	Melting Temperature	Tensile Strength tons/sq."	Elongation %	Brinell Hardness
A	185° C.	4.9	20	13.9
B	205° C.	4.4	67	12
C	230° C.	4.1	63	11.3
D	255° C.	3.8	53	8.7
F	210° C.	3.8	69	12
K	185° C.	4.0	52	13.9

DIPPING SOLDERS

Number	Recommended Bath Temperature	Weight	
		lb./cubic inch	lb./cubic feet
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2	350° C.	0.352	608.25
3	400° C.	0.372	642.8

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L.S.1	305/312° C.	7.1	5.35	3.0
L.S.2	305° C.	7.1	4.95	3.0

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Grade	Melting Temperature		Grade	Melting Temperature	
Fry's No. 2 Alloy	70° C.	158° F.	Fry's Tube Bending Alloy	71° C.	160° F.
Fry's No. 9 Alloy	93° C.	203° F.			
Fry's No. 15 Alloy	138° C.	281° F.	Fry's Alloy for Die and punch mounting	120° C.	248° F.
Fry's No. 17 Alloy	124° C.	256° F.			

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"Fry's Oleic Acid No. 9"	W.O. CWD/275/C / I.N.O. K/767		
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"Fryolene" Paste Flux	Rapid action, Non-corrosive Flux for Ferrous and Non-ferrous Metals		
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being done in research in regard to this blistering since by finding the reason for it they might be able to overcome it.

DR. MARTIN, in his reply, suggested that the trouble could be largely overcome by refiring the casting before it got cold.

MR. DONALDSON remarked that this was his experience but he wanted to know if anything was being done to make it possible to recoat and refire a casting which had been processed some days before and had been returned to the enamelling shop for touching up due, say, to its having been chipped in fitting or in transit.

DR. MARTIN said that blistering had caused considerable trouble in the past but refiring had been done successfully in some works. Sometimes a second coat of wet-process enamel could be applied and the casting refired without any trouble, while in another case it was not successful at all. One factor seemed to be the type of enamel used. One firm could refire castings without any trouble, using a silicon content generally regarded as low, *i.e.*, 2.2 per cent. The foundryman insisted that if he exceeded 2.5 per cent. the castings could not be refired without blistering. He preferred to maintain the silicon content at 2.2, as it created no other difficulties.

There was one way in which this effect was being overcome, and that was by applying and firing the next coat as soon as possible—as soon as the coating was cool enough to handle. Nine times out of ten this would be successful. He had not made any experiments to show the cause of blistering on refiring but he hoped to do so in the future. When the enamel was fused it should thereby have sealed the surface from the atmosphere and one could not reasonably expect any further oxidation leading to gas evolution.

Composition of Iron for Bath Tubs

MR. R. URE said he was only interested in the iron aspect of the matter. If excessive manganese were present blistering would, invariably, occur to some extent. If it was in excess of 1 per cent. in a bath casting blistering would always occur. The quantity of manganese present in castings to be enamelled in the Falkirk district ought to be substantially increased. If a mixture for melting contained 1.2 per cent. manganese only 0.8 per cent. would be found in the casting. The ideal iron for bath castings would be one with 2.4 to 3.0 per cent. silicon; 0.03 to 0.06 sulphur, 0.9 to 1.1 phosphorus and manganese about 1 per cent. The total carbon was usually about 3.5 per cent. with only a trace being in the combined condition. If the local foundrymen could invariably reproduce this composition they would attract the whole bath trade to the district, provided the pig-iron was of high quality and cast at the correct temperature from the blast furnace.

DR. MARTIN confirmed Mr. Ure's statement by referring to the samples of iron analysed for the local foundries when usually the manganese content was returned at about 0.30 per cent. The solution was largely a question of suitable pig-iron He had advised people in such cases to use pig-iron with higher manganese. With regard to the suggested 2.4 to 3.0 per cent. silicon, there was plenty of latitude indicated.

Reactivity of Blast-Furnace Slags

The reactivity of blast-furnace slags has been investigated by F. J. NELLENSTEYN and G. M. A. STEFFELAAR, according to a Paper in "Chemisch Weekblad," by examining the velocity of decomposition of hydrogen peroxide on adding various blast-furnace slags. Slags containing less than 1 per cent. Fe cause a very rapid decomposition of the peroxide, while as the Fe content is increased the reactivity is depressed almost to vanishing point.

Institute of British Foundrymen

ANNUAL MEETING OF EAST MIDLANDS BRANCH

The East Midlands Branch of the Institute of British Foundrymen held the annual general meeting recently at Loughborough College, the retiring Branch-President, Mr. R. H. Buckland, being in the chair. The minutes of the preceding annual general meeting having been adopted, Mr. B. Gale, hon. secretary, presented his report for the past session. Its most important features are extracted below.

Secretary's Report

The outbreak of war caused a temporary dislocation of activities and the first meeting of the session had to be postponed, but normal activities were soon resumed, and the October, November and December meetings were well attended. The January meeting had only 20 members present, but in view of the appalling weather conditions this was considered to be a very satisfactory figure. Weather was responsible for the cancellation of the February meeting, an action that had never before been known in the Branch.

The annual dinner was highly successful; the attendance was actually 74, and several late applications for tickets had to be refused as the accommodation available was exhausted. This gathering was an outstanding tribute to the Branch members' interest.

During the year seven new members were elected, but with one or two resignations and a number of transfers the actual membership shows a net decrease of five since the last annual meeting. The present membership consists of 1 honorary life member, 4 subscribing firms, 57 members, 85 associate members and 3 associates, making a total of 150. In addition the Lincoln section has 8 members and 12 associate members, bringing the grand total for the Branch up to 170. Of this number the secretary has definite information that two members are at present serving with the Forces, and he would be pleased to receive notification of others similarly placed. The Branch and the Institute are anxious to keep record of such members, and the General Council have decided that the subscriptions of these members will be waived whilst they are on service.

Subscription income was rather below the average for the year, and the arrears to be carried forward were excessive. Much of the arrears had been paid during the early months of 1940, but there was still a fairly large balance outstanding when this report was written, and an appeal is made to the members concerned to make payment as soon as possible.

The Branch has been fortunate during the session in having lecturers to attend all the meetings so far arranged, and warm thanks are due to them for their presence to deliver Papers, and also to Mr. Ben Hird, who had made all arrangements for his Paper, which was unfortunately cancelled as previously mentioned.

Commenting on the Report, MR. BUCKLAND said every one highly esteemed the work done by Mr. Gale as secretary. The position of Branch-President had impressed him with the large amount of work the secretary had to do.

Election of Officers

The election of officers for the next session resulted as follows:—*Branch-President*, Mr. S. E. Dawson, F.I.C.; *Senior Vice-President*, Mr. H. J. Beck; *Junior Vice-President*, Mr. B. Gale; *Honorary Secretary*, Mr. S. A. Horton; *Hon. Auditors*, Mr. W. H. Smith and Mr. B. Gale; *Delegates to the General Council*, Mr. H. J. Beck and Mr. A. E. Peace; *Representatives on the Technical Committee*, Mr. P. A. Russell, B.Sc., and Mr. A. E. Peace.

Change of Secretaryship

MR. BUCKLAND announced with regret that Mr. Gale, their present secretary, had found it necessary to tender his resignation. On behalf of the members he expressed to Mr. Gale their very hearty appreciation for his services during the period of six years.

MR. GALE said in some respects he was sorry to have found it necessary to resign, but the pressure of his work made it impossible to carry on the secretarial duties. He thanked Mr. Buckland and the members for their many signs of appreciation, and now that he had been elected as Junior Vice-President he hoped still to be able to serve the Branch.

MR. H. BUNTING, in proposing Mr. S. A. Horton's election as secretary, said that gentleman would be following an efficient secretary, and it was always difficult at the outset to maintain the standard of a predecessor, but the speaker had every confidence that Mr. Horton would serve them as well as his predecessor had done.

MR. HORTON, thanking the members for the confidence shown in him, hoped that with their assistance the work would go forward satisfactorily to all.

Following the annual general meeting, a Short Paper Competition was held. Five Papers were read by Mr. P. A. Russell:—(1) "Power or Hand Machines?" by J. N. Sherar; (2) "Youth and the Foundry," by J. C. Hallamore; (3) "Iron Foundry Practice and its Effect on Mechanical Tests," by D. Lawrence; (4) "Some Aspects of Control in the Repetition Foundry," by A. B. Bill, and (5) "The Draughtsman and the Foundry," by H. Prince.

There were two prizes, the first prize being awarded to Mr. A. B. Bill and the second prize to Mr. J. C. Hallamore. A discussion followed on the winning Paper, which is printed on page 328 of this issue.

Foundry Uses of Models

By "FOUNDRYMAN."

Moulders have not always been so proficient in the art of reading engineering drawings as they are to-day, and often when new and unfamiliar castings were required the patternmaker made a rough model of the job to enable the moulder to express his opinion on the method of manufacture to be adopted prior to any paternmaking being commenced. Another use of models to the moulder was in connection with loam-sweeping jobs, in which certain pieces of pattern-work had to be introduced during building, and mistakes as to the "hand" could easily be made.

A use of models to the patternmaker is in connection with small intricately-cored castings in which the number of sections shown on the drawing is insufficient to obtain correct shapes at all points for the numerous cores involved and thus ensure even metal thickness throughout. The method is to make wood models of each core as nearly correct as possible from the information given, and assemble them in a mould and test the thickness between them with clay. If the thickness be insufficient the models are pared to give the requisite amount, and they are then used as guides for the formation of core boxes to give cores exactly similar to the models. This method ensures a correct casting, and the little extra expense involved in preparing and trying the models is more than compensated by the accuracy obtained.

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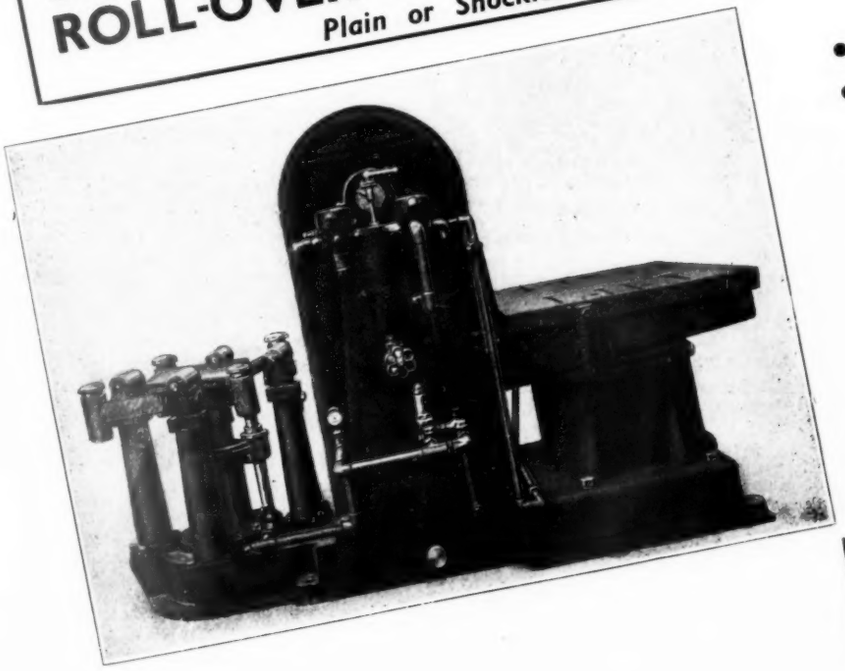

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The Week's News in Brief

Trade Talk

THE NEW RESEARCH LABORATORY of High Duty Alloys, Limited, of Slough, was officially opened last Tuesday by Sir Henry T. Tizard, K.C.B., F.R.S., Rector of the Imperial College of Science and Technology. A description of these excellently equipped laboratories will be published next week.

A NEW ARC-WELDING electrode, made as two types, is announced by the Lincoln Electric Company, Limited, of Welwyn Garden City, Herts. They are known as "Faceweld" electrodes and are cast from abrasion-resisting alloys used for hard-facing by the metallic arc process. As many of the components for which they are applicable are castings, they will be of special interest to some of our readers.

FIVE EMPLOYEES of Glenfield & Kennedy, Limited, Kilmarnock, were presented last week with gold medals on completion of 50 years' continuous service with the company. They were Mr. Robert Brown; Mr. James Cook; Mr. James Gilmour; Mr. William Beattie, and Mr. James Barclay (foundry). Mr. E. Bruce Ball (managing director), presenting the medals, said that since 1930 50 of these medals had been awarded.

THE National Union of Blastfurnacemen have arrived at an agreement with the National Council of the Association of Iron Masters to stabilise the wages of the men in the blast-furnace industry at 67 per cent. on base rates plus 1s. 3½d. net per shift. This figure represents a cost-of-living figure at 77. For adults, 8d., and for youths, 4d. increase will be added for each point the cost of living rises above 77. The agreement will operate from the first full pay in May.

THE BOARD OF TRADE announced the formation of several further Export Groups last week. They include the following: Brassfounders' Export Group (secretary, Mr. F. J. Collis, 106, Edmund Street, Birmingham, 2); Electrical Goods and Apparatus Export Committee (Mr. Felix Rogers, 36, Kingsway, London, W.C.2); Gas Appliance Manufacturers' Export Group (Mr. D. A. Japes, Radiation House, Aston, Birmingham, 6); Hearth Furniture and Art Metalware Export Group (Mr. H. Eyles, 95, New Street, Birmingham, 2).

THE LIGHT-CASTINGS TRADE of the Falkirk district has suffered very much by the stoppage of the building industry. Mr. Hugh Murdoch, secretary of the Ironfounding Workers' Association, in his annual report states that during the year the membership has decreased from 12,001 to 11,117. During the past few weeks in the Falkirk district the number of idle workers had been increasing whereas elsewhere in Scotland and in England it was inclined to decrease. The unemployment figures, however, compared with those of a year ago, were all over much lower.

Foundry Equipment Export Group

We are informed that Mr. Geo. E. France, of August's, Limited, Thorn Tree Works, Halifax, who was recently re-elected President of the Foundry Trades' Equipment and Supplies Association, has been entrusted by the Export Council to undertake the formation of a Foundry Equipment Export Group. This Group, generally speaking, will cover "all items of machinery or equipment specifically designed or manufactured for use in foundries." Firms within the trade have received a circular informing them of steps being taken to hold a meeting in London next week to inaugurate the Group, to elect officers, and to hear an address by a representative of the Export Council. Foundry equipment and machinery manufacturers who may not have received these particulars yet should communicate with Mr. France without delay.

Obituary

MR. JOHN AULD, of David Auld & Sons, Limited, Whitevale Foundry, Glasgow, has died at Bridge of Allan.

MR. JOHN W. NICKLIN died at his home at Smethwick recently, at the age of 69. He was a member of the firm of James C. Nicklin, Limited, iron and steel merchants.

Personal

SIR DAVID EZRA has been elected a director of the Steel Corporation of Bengal, Limited.

MR. ALAN FINDLAY is retiring from the position of general secretary of the United Patternmakers' Association.

MR. W. A. WOODESON, chairman of Clarke, Chapman & Company, Limited, Gateshead, was elected President at the annual meeting last month of the North-East Coast Institution of Engineers and Shipbuilders.

MR. C. M. SPIELMAN, a director of the Whessoe Foundry & Engineering Company, Limited, Darlington, was elected President of the Tees-side Chamber of Commerce at the annual meeting at Middlesbrough last week.

MR. C. W. BIGG has resigned from the position of Director for Iron Castings (Iron and Steel Control—Ministry of Supply), owing to pressure of business consequent upon his firm being very busy with armament orders.

SIR RONALD MATTHEWS, who has been elected President of the Association of British Chambers of Commerce, is a former Master Cutler and a former President of the Sheffield Chamber of Commerce. He is chairman of the Brush Electrical Engineering Company, Limited, and General Refractories, Limited, a director of J. & G. Wells, Limited, and vice-chairman and managing director of Turton Bros. & Matthews, Limited, Sheffield.

SIR CHARLES CRAVEN has joined the Air Council as Civil Member for Development and Production. His new appointment will be whole time. Sir Charles will also be chairman of the Air Supply Board, which will replace the existing Air Council Committee on Supply. The Air Supply Board will be responsible under the Air Council for the production of aeronautical equipment and supplies. Sir Charles Craven, on taking up his appointment, has dissociated himself from the boards of Vickers, Limited, Vickers-Armstrongs, Limited, and all associated companies, and has ceased to take any part in the conduct of their affairs.

Conservation of Paper

Owing to the necessity of conserving supplies of paper, the publishers of THE FOUNDRY TRADE JOURNAL—*in common with all other publishing firms—can no longer accept "returns" of unsold copies from newsagents. This means that casual copies will not be available, and readers buying the* JOURNAL *from a newsagent will need to place a firm order for its reservation each week. Copies may also be secured through the post by direct subscription, in which case an order should be sent to the Subscription Department,* THE FOUNDRY TRADE JOURNAL, *3, Amersham Road, High Wycombe, Bucks. The annual rate is 17s. 6d. in the United Kingdom, post free.*

Applications for Trade Marks

The following list of applications to register trade marks has been taken from the "Trade Marks Journal":—

"SIXMAX"—High-speed steel. ATLAS STEELS, LIMITED (CANADA), c/o H. D. Fitzpatrick & Company, 94, Hope Street, Glasgow, C.2.

"JEVCO"—Pipe joints and couplings. E. E. Jeavons & Company, Limited, Lower Church Lane, Tipton, Staffs.

"VINCIT" AND "VINCITRITE"—Abrasive tools. United Carborundum & Electrite Works, Limited, Stamp End Works, Lincoln.

"PEGSON-MARLOW MUD HOG" (DEVICE)—Pumps for muddy water. Marlow Pumps, c/o Henry Cross & Son, 2, Derby Street, Prescot, Lancs, and Pegson, Limited, Minotaur Works, St. Saviours Road East, Leicester.

"CARBORUNDUM" (CIRCULAR DEVICE CONTAINING IMPRESSION OF AN AMERICAN INDIAN'S HEAD)—Grinding, polishing and sharpening wheels, hones, etc., made of silicon carbide. Carborundum Company, Limited, Trafford Park, Manchester.

Company Meeting

International Nickel Company of Canada, Limited

The annual meeting of the International Nickel Company of Canada, Limited, was held in Toronto on April 24. MR. ROBERT C. STANLEY (chairman and president) said that the year under review marked the beginning of the second decade since the acquisition of the Mond Nickel Company of England, which made their enterprise truly international in character. During this period the company made substantial progress, as evidenced by the fact that the average annual sales of their metals for the past three years exceeded those of 1929 by a wide margin. Since hostilities began all export sales of nickel, copper and platinum metals had been made under Canadian Government permits and with the sanction of the British Government. Sales of nickel in all forms totalled 210,194,135 lbs., an amount slightly in excess of the previous peak year, 1937, in which 207,700,943 lbs. of nickel were sold. The markets in the United States alone consumed 101,200,000 lbs., or 10,600,000 lbs. more than in any past year. It was, therefore, significant that the peak year for nickel sales might be attributed more particularly to the commercial demands in the United States than to Government war requirements.

Contracts Open

London, S.W., May 7—Brassfoundry for furniture, etc., for the Commissioners of H.M. Works. The Controller of Supplies, H.M. Office of Works, etc., Dean Bradley House, Horseferry Road, Westminster, London, S.W.1.

Surbiton, May 11—Cast-iron manhole covers and frames, tools, etc., for 12 months from July 1, for the Corporation. The Borough Engineer and Surveyor, Council Offices, Surbiton.

Cairo, May 15—Foundry crucibles, single and double leather belts and hair belting, for the Ministry of Education, Stores Department. (D.O.T. reference: T. 18,050/40.)

Northampton, May 18—Supply and erection of submersible pumping plant, etc., for the Wootton water supply scheme, for the Rural District Council. Mr. R. J. Miller, surveyor, 1, Spencer Parade, Northampton.

Northampton, May 21—Provision and laying of approx. 3,700 yds. of 4-in. and 3-in. dia. spun-iron mains, etc., for the Wootton water supply scheme, for the Rural District Council. Mr. R. J. Miller, surveyor, 1, Spencer Parade, Northampton.

Shardlow, May 10—Supplying and laying about 660 yds. of 6-in. and about 315 yds. of 4-in. spun-iron pipes at Melbourne, Derbyshire, for the Rural District Council. Elliott & Brown, consulting engineers, Stanley House, Pelham Road, Nottingham. (Fee £3 3s., returnable.)

Forthcoming Events

MAY 2-3.

Iron and Steel Institute:—Annual meeting in London at offices of the Institute, 4, Grosvenor Gardens, at 10 a.m. Members' luncheon on Friday at Grosvenor House, Park Lane, at 1 p.m.

MAY 7.

Institute of Metals:—General meeting at Institution of Mechanical Engineers, Storey's Gate, London, S.W.1, at 2.30 p.m., for discussion of the following Papers: "Influence of Alloying Elements on Crystallisation of Copper. II.—Large Additions and Part Played by the Constitution," by L. Northcott; "Structural Changes in Copper Effected by Cold-Rolling and Annealing," by M. Cook and T. Ll. Richards; "Ageing of High-Purity 4 per cent. Copper-Aluminium Alloy," by M. L. V. Gayler and R. Parkhouse.

MAY 8.

Institute of Metals:—"Engineering and Atomic Transmutation," Annual May Lecture by Prof. J. D. Cockcroft, at Institution of Mechanical Engineers, Storey's Gate, London, S.W.1, at 7 p.m.

MAY 9.

Institute of Metals (London Section):—Annual meeting, followed by general discussion on "Utilisation of Secondary Metals," opened by J. A. A. Fraser, at Caxton Hall, Caxton Street, London, S.W.1, at 7 p.m.

Institute of British Foundrymen

MAY 8.

London Branch:—"Notes on Producing Sound Castings in Iron." Paper by P. D. Pincott, at Charing Cross Hotel, London, W.C.2, at 7 p.m.

MAY 9.

East Anglian Section:—"Oxy-Acetylene Welding of Cast Iron." Paper by L. Tibbenham, at Central Library, Ipswich, at 7 p.m.

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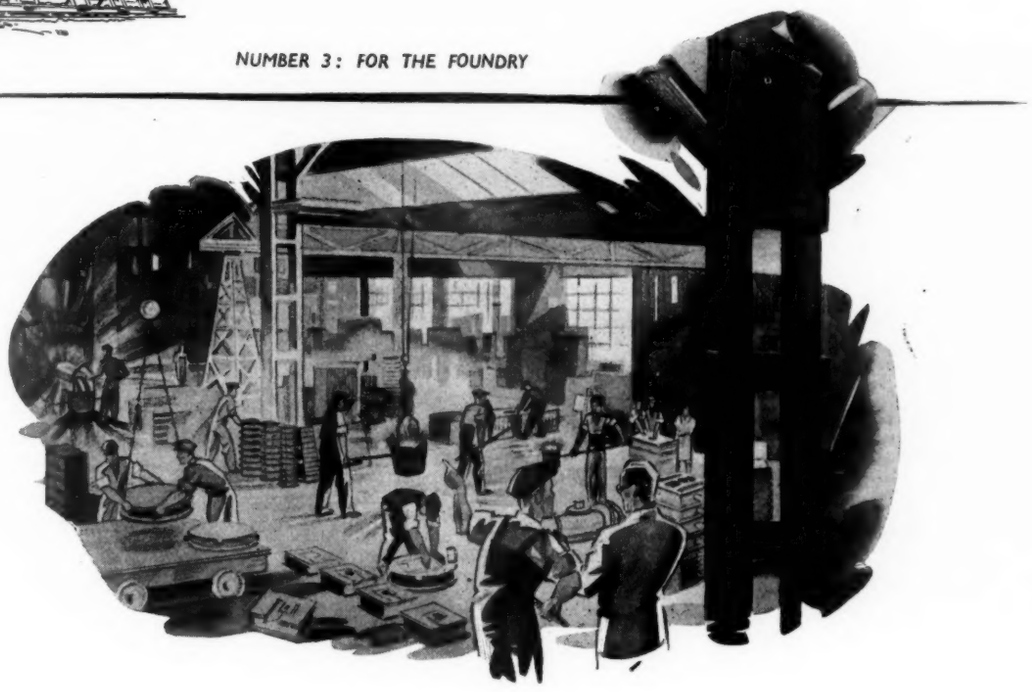

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Raw Material Markets

The iron and steel trade has now been able to give a considered verdict on the Chancellor's Budget proposals as they affect commercial and industrial concerns. There has not been any large amount of adverse criticism, the industry realising that the nation is fighting a war which must be won and that the ultimate result depends much on the industrial effort. Iron and steel companies have for some time past been coming more and more under the influence of State control, and Sir John Simon's moves to take the profit out of the war surprised no one. The chief source of discontent at the moment lies in the higher railway rates recently introduced, which, in addition to the increased demurrage charges, present a very heavy burden to manufacturers. With these new costs of production, the makers' case for an early revision of existing selling prices is materially strengthened.

Pig-Iron

MIDDLESBROUGH—Engineering, shipbuilding and other branches are making big demands for heavy castings on concerns in this area. The production of Cleveland iron being still suspended, the requirements of consumers in the district are being met by Midlands producers, and, on the whole, satisfactory tonnages are coming to hand, though the surplus is not large. The question of an increase in prices of iron and steel is occupying makers' attention in view of the recent advances in production costs, and it is hoped that the Control's early consideration will be given to this question. The 10 per cent. increase in railway rates is no small matter to the iron and steel trade, as only perhaps the coal industry is more severely affected.

East Coast hematite is in insistent request, and makers have to exercise keen judgment in the allocation of supplies. After the needs of the steelworks have been met there is only a comparatively meagre tonnage available for disposal. Merchants would welcome an expansion of outputs, but this can only be done slowly.

LANCASHIRE—The most active pig-iron users in this district continue to be the speciality engineers, while jobbing foundries generally are well placed for work. Textile machinists, too, are fairly busy, but improvement in the light-castings trade is only moderate. The outlook does not promise an early change in this respect, but a material advance may be made if the export drive gets under way. West Coast hematite is well taken up.

MIDLANDS—Owing to the quiet state of the light-castings trade, the demand for high-phosphorus iron is easily satisfied. There is no large amount of war work available in this industry, and peacetime outlets have shrunk considerably. Heavy engineers are almost completely engaged on Government contracts and low-phosphorus iron and hematite are both passing into immediate consumption. The past week or two has shown an improvement in deliveries, but all available iron is urgently required. Basic iron is in strong demand by the steel industry; several furnaces formerly making high-phosphorus iron are now employed on the manufacture of basic, which has eased the pressure to some extent.

SCOTLAND—Trade in and around Falkirk continues to be dull, owing to the meagre call for light castings, but it is hoped that conditions will improve following the recent visit of a representative of the Ministry of Supply, who discussed the problems of the industry with the makers themselves. Short time is common at many works. Heavy engineers, on the other hand, are very busy, being largely employed on the expanding needs of the shipbuilding yards.

Coke

Deliveries of foundry coke are at an unusually high level for the time of the year, owing to the widespread desire to accumulate reserves at the consuming plants, as a precaution against possible interruptions in transport later. Supplies are adequate. In addition to the demand for the purpose of building up stocks, there is also a strong buying movement for current requirements, which are larger than in peace-time. For delivery to Birmingham and Black Country stations, the price of Durham best foundry coke is 53s. per ton, but forward business is transacted only on the understanding that consumers bear the higher prices which may be introduced by the Control authorities at any time.

Steel

The operation of the new distribution scheme for the steel industry is engaging the earnest attention of all sections of the trade. Makers are relieved in so far as they now have to comply with the instructions of the various Government departments instead of having to work out delivery destinations themselves, while the scheme allows users to plan their business ahead, as they are aware in advance of the amount of steel to be sent to them over a given period. There is not, of course, any large amount of steel available for the ordinary domestic user, owing to the heavy tonnages involved in munitions contracts, but sympathetic consideration is accorded to all inquiries. The industry, as a whole, is fully booked up for the first half of the year at least, and producers are reluctant to add any heavy commitments to their already well-filled order-books.

Scrap

A great deal of publicity has been given to the nation's need for scrap iron and steel, as a result of which valuable shipping space has already been saved. Nevertheless, the public is still not altogether aware either of the value of scrap to the war effort or of the material which comes into the category of scrap, and there is a large tonnage in all parts of the country which will eventually have to find a place in the war machine. Better deliveries are being made to consuming works, but all material finds a ready market.

Metals

World tin production in March is estimated at about 22,000 tons, according to the April issue of the Statistical Bulletin of the International Tin Research and Development Council, Fraser Road, Greenford, Middlesex (price 1s.). This makes for the first quarter of 1940 a total of 52,600 tons, as compared with 72,500 tons in the preceding quarter. In February, production was estimated at 15,700 tons, and in January 14,900 tons. The quota operating in March was 120 per cent., but this has since been reduced to 80 per cent. World apparent tin consumption in the period under review is estimated at 62,400 tons, against 53,000 tons in the last quarter of 1939. Estimating the United States' consumption in March at 10,000 tons, the total apparent consumption in the U.S.A. in the quarter under review will have amounted to 25,000 tons, leaving about 37,000 tons for all other countries. During the first quarter of this year the visible supply decreased by 2,040 tons, and the smelters' stocks (including the carry-over) by 1,135 tons, making a decrease of 3,175 tons in the total stocks.

Following her recent buying interest in the United States market, Italy is understood to have made inquiries for further supplies, but, owing to the fact that export licences from Malaya are granted only sparingly, little success is reported to have greeted the Italian efforts. Yugoslavia has been endeavouring to acquire more tin, as also have Rumania and Bulgaria. The tin market in London has been quite firm, with the continuance of a backwardation between cash and three months' metal.

Metal Exchange prices for tin this week have been as follow:—

Cash—Thursday, £255 to £255 10s.; Friday, £255 10s. to £256; Monday, £254 15s. to £255; Tuesday, £253 5s. to £253 10s.; Wednesday, £253 to £253 10s.

Three Months—Thursday, £250 to £250 5s.; Friday, £250 15s. to £251; Monday, £250 15s. to £251; Tuesday, £248 15s. to £249; Wednesday, £249 15s. to £250.

In spelter it is increasingly obvious that the Control authorities are looking after the needs of the munitions programme, comparatively meagre tonnages being made available to ordinary domestic consumers.

Lead is being used in larger tonnages for munitions purposes, while, in spite of the decline in the building trade, a big tonnage is being consumed in domestic work. There is a continued quiet demand generally for non-ferrous scrap.

Reports and Dividends

Ransomes, Sims & Jefferies, Limited—Net profit for 1939, £75,436; brought in, £52,144; to reserve, £25,000; dividend on the ordinary stock of 7½ per cent.; carried forward, £54,080.

Robey & Company, Limited—Profit for 1939, £28,136; balance after providing for interest, depreciation and other charges, £15,955; brought in, £4,864; interest on the income debenture stock, £2,250; sinking fund, £258; dividend of 5 per cent. on the non-cumulative preference shares, £3,017; dividend of 5 per cent. on the ordinary shares, £3,905; carried forward, £11,388.

New Companies

(From the Register compiled by Jordan & Sons, Limited, Company Registration Agents, 116 to 118, Chancery Lane, London, W.C.2.)

Western Foundry Supplies, Limited, 7, St. Stephen Street, Bristol, 1—Capital £2,000. Directors: S. G. Ward, J. F. Gist and F. Jackson.

John Needham & Sons (Manchester), Limited, 15, Cross Street, Manchester—Capital, £20,000. Steel, iron and metal merchants and manufacturers, etc. Directors: Sir Richard A. Needham and J. A. Hobson.

EMPLOYMENT REGISTER.

Correspondence should be addressed to the General Secretary, Institute of British Foundrymen, St. John Street Chambers, Deansgate, Manchester, from whom full particulars can be obtained of this service.

FOUNDRY METALLURGIST requires responsible situation. Non-ferrous preferred. Sound experience both in foundry and laboratory. Good references. Age 29. (379)

CHEMIST, ferrous, non-ferrous analysis, physical testing, photomicrography, etc., seeks position. (380)

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